DOCUMENT RESUME

ED 038 527 VT 010 765

TITLE Agricultural Equipment Technology: A Suggested 2-Year Post High School Curriculum.
INSTITUTION Office of Education (DHEW), Washington, D.C.
REPORT NO OE-81015
PUB DATE 70
NOTE 120p.
AVAILABLE FROM Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (FS5.281:81015, $1.25)

EDRS PRICE EDRS Price MF-$0.50 HC Not Available from EDRS.
DESCRIPTORS *Agricultural Engineering, *Agricultural Technicians, *Curriculum Guides, *Equipment, Post Secondary Education, Program Development, Technical Education, *Vocational Agriculture

ABSTRACT

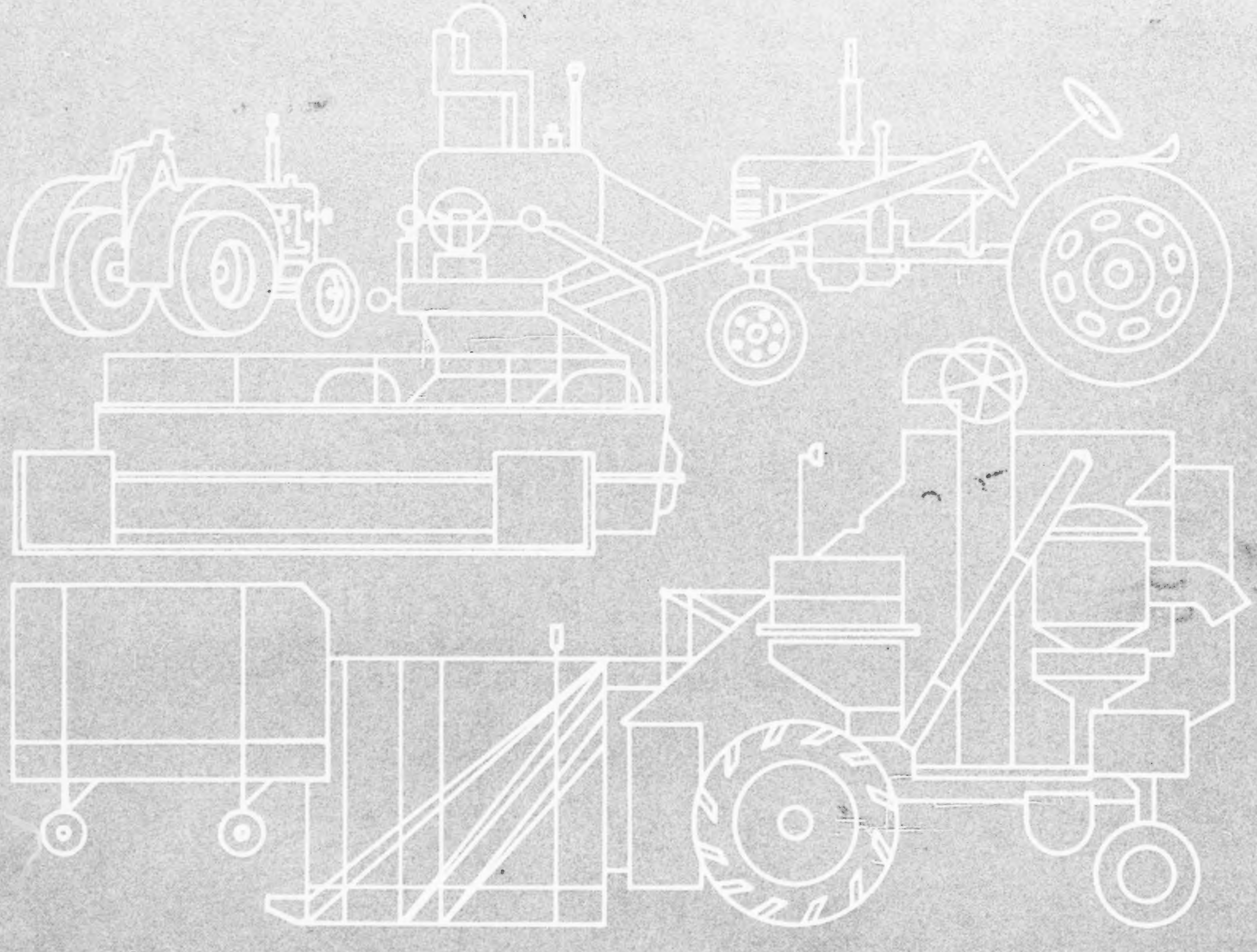
Developed by a subject matter specialist, this suggested curriculum guide is intended to assist school administrators, advisory committees, supervisors, and teachers in planning and developing new programs or evaluating existing ones in agricultural equipment technology. The guide provides suggested course outlines, including examples of texts and references, a sequence of technical education procedure, farm land requirements, laboratory layouts with equipment and costs, a selected list of scientific, trade, and technical societies, and special library, faculty, and student services. Grouped under the general headings of technical courses, mathematics and science courses, auxiliary and supporting technical courses, and general courses, the 25 course outlines include: (1) Agricultural Chemical Equipment, (2) Farm Power, (3) Principles of Farm Mechanization, (4) Welding, (5) Applied Mathematics, (6) Applied Physics, (7) Accounting for Agricultural Equipment Business, (8) Agricultural Equipment Technology Seminars, (9) Selling, Distributing and Diagraming, (10) Technical Reporting, (11) American Institutions, and (12) General and Industrial Economics. The 215-hour program may be adapted to meet local, state, and regional needs. (AW)

OE-81015
OE/BAVLP
VT

ED0 38527

Agricultural Equipment Technology

A Suggested 2-Year Post High School Curriculum



VT010765

DISCRIMINATION PROHIBITED—Title VI of the Civil Rights Act of 1964 states: "No person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance." Therefore, the Vocational and Technical Education program, like all programs or activities receiving financial assistance from the Department of Health, Education, and Welfare, must be operated in compliance with this law.

ED038527

OE-81015

AGRICULTURAL EQUIPMENT TECHNOLOGY

A Suggested 2-Year Post High School Curriculum

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF EDUCATION

ROBERT H. FINCH, ***Secretary***

JAMES E. ALLEN, JR., ***Assistant Secretary and Commissioner of Education***

Superintendent of Documents Catalog No. FS 5.281:81015

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1970

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price $1.25

FOREWORD

THIS SUGGESTED CURRICULUM was prepared to assist the States and other interested organizations and institutions in planning and developing programs to meet the Nation's increasing needs for qualified agricultural equipment technicians. The guide suggests course outlines with examples of texts and references; a sequence of technical education procedure; farm land requirements; laboratory layouts with equipment and cost; special library, faculty, and student services; and a selected list of scientific, trade, and technical societies. It is designed to assist school administrators, advisory committees, supervisors, and teachers who will be planning and developing new programs or evaluating existing programs in agricultural equipment technology. Although the indicated level of instruction is post high school, the sequence of course work may start at any grade level where students have the prerequisite background and understanding.

This material was developed by Walter J. Brooking, Technical Education Specialist, Program Development Branch, Division of Vocational and Technical Education, Office of Education. The basic materials were prepared by the State University of New York, Agricultural and Technical College, Cobleskill, N.Y., pursuant to a contract with the Office of Education.

Many useful suggestions were received from special consultants, advisers, and owners and employers in the agricultural equipment and farming industry community, and from administrators and teachers in schools of technology. Although all suggestions could not be incorporated, each was considered carefully in the light of the publication's intended use. Therefore it should not be inferred that the curriculum is completely endorsed by any one institution, agency, or person. It is a plan for a program; a plan to be modified by administrators and their advisers to meet local, State, and regional needs.

Grant Venn
Associate Commissioner for
Adult, Vocational, and Library Programs

August 15, 1969

ACKNOWLEDGMENTS

THE U.S. OFFICE OF EDUCATION, Division of Vocational and Technical Education, recognizes the valuable contributions made in the detailed review of this publication by the following men:

Richard H. Bittner, Coordinator, Agriculture Engineering Department, Michigan State University, East Lansing, Mich.

Aubrey M. Briscoe, Head, Department of Agriculture, Northwest Mississippi Junior College, Senatobia, Miss.

J. G. Chambliss, Professor, Agricultural Engineering, Abraham Baldwin Agricultural College, Tifton, Ga.

John E. Davidson, Associate Professor, Business Administration, State Universtiy of New York, Agricultural and Technical College, Cobleskill, N.Y.

Donald G. Demick, Associate Professor, Agricultural Engineering Technology, State University of New York, Agricultural and Technical College, Cobleskill. N.Y.

Ransom Evans, Assistant Professor, Business Administration, State University of New York, Agricultural and Technical College, Cobleskill, N.Y.

G. E. Henderson, Coordinator, American Association for Agricultural Engineering and Vocational Agriculture, Athens, Ga.

Jerry J. Halterman, Coordinator of Agriculture, Chico State College, Chico, Calif.

Carlton E. Johnson, Professor, Department of Agricultural Engineering, Ohio State University, Columbus, Ohio.

Alan H. Lamb, Executive Secretary, New York Farm Equipment Dealers' Association, Inc., Hamilton, N.Y.

Eugene C. Lamb, Agricultural Sales Representative, Northeastern District, Ford Motor Company, Latham, N.Y.

John Leverett, Professor, Science and Mathematics, State University of New York, Agricultural and Technical College, Cobleskill, N.Y.

Theodore C. Lyon, Associate Professor, Accounting, State University of New York, Agricultural and Technical College, Cobleskill, N.Y.

John W. Matthews, Vocational Agriculture Service and Agricultural Engineering, University of Illinois, Urbana, Ill.

Edward B. Mott, Professor, Agricultural Engineering Technology, State University of New York, Agricultural and Technical College, Cobleskill, N.Y.

Harold L. Noakes, Associate-in-Charge, Bureau of Agricultural Education, State Education Department, Albany, N.Y.

Ernest F. Nohle, Associate, Bureau of Agricultural Education, State Education Department, Albany, N.Y.

Robert E. Norton, Agricultural Education Division, Cornell University, Ithaca, N.Y.

Kenneth W. Olcott, Assistant Professor, State University of New York, Agricultural and Technical College, Cobleskill, N.Y.

F. W. Peikert, Professor and Head, Department of Agricultural Engineering, The Pennsylvania State University, University Park, Pa.
Robert R. Stockbridge, Chairman, Agricultural Department, Agricultural and Technical College, Farmingdale, N.Y.
Willard R. White, White's Farm Supply, Inc., Canastota, N.Y.

The Office of Education also acknowledges with appreciation the constructive criticism by administrators, representatives, and staff members of the following agencies or institutions:

Abraham Baldwin Agricultural College
Tifton, Ga.

Allis-Chalmers Manufacturing Co.
Milwaukee, Wis.

California State Polytechnic College
San Luis Obispo, Calif.

Colorado State University
Fort Collins, Colo.

J. I. Case Co.
Racine, Wis.

Deere and Co.
Moline, Ill.

Ford Tractor Division
Ford Motor Co.
Birmingham, Mich.

Fresno State College
Fresno, Calif.

University of Georgia
Athens, Ga.

International Harvester Co.
Chicago, Ill.

Kansas State University
Manhattan, Kans.

Massey-Ferguson, Inc.
Indianapolis, Ind.

Michigan State University
East Lansing, Mich.

Milwaukee School of Engineering
Milwaukee, Wis.

Modesto Junior College
Modesto, Calif.

Mt. San Antonio College
Walnut, Calif.

New Holland Machine Company
New Holland, Pa.

Sequoia College
Visalia, Calif.

State Board of Education
Raleigh, N.C.

State Department of Education
Sacramento, Calif.

State Department of Education
Denver, Colo.

State University of New York
Agricultural and Technical College
Alfred, N.Y.

Sussex County Vocational-Technical School
Georgetown, Del.

Texas Technological College
Lubbock, Tex.

Virginia Polytechnic Institute
College of Agriculture
Blacksburg, Va.

Wayne Technical Institute
Goldsboro, N.C.

Western Retail Implement and Hardware Association
Kansas City, Mo.

Wilson County Technical Institute
Wilson, N.C.

CONTENTS

Page

FOREWORD iii

ACKNOWLEDGMENTS iv

THE AGRICULTURAL EQUIPMENT INDUSTRY 1

GENERAL PROGRAM CONSIDERATIONS 2

- Special Abilities Required and Activities Performed by Agricultural Equipment Technicians 4
- Faculty 6
- Student Selection and Services 8
- Farm and Laboratory Equipment and Facilities 9
- Library 10
- Scientific and Technical Societies 11
- Advisory Committees and Services 12

THE CURRICULUM 13

- Curriculum Outline 13
- Brief Description of Courses 14
- Curriculum Content and Relationships 17
- Cooperative Education Plan 18
- Suggested Continuing Study 19

COURSE OUTLINES 20

- Technical Courses 21
  - Agricultural Chemical Equipment 21
  - Farm Power I (Gas Engines) 22
  - Farm Power II (Diesel) 25
  - Harvesting Equipment 27
  - Hydraulics I (Basic) 29
  - Hydraulics II (Equipment Applications) 32
  - Planting and Tillage Equipment 33
  - Power Unit Testing and Diagnosis 35
  - Principles of Farm Mechanization 37
  - Transmissions and Final Drives 39
  - Welding I (Elementary) 41
  - Welding II (Advanced) 42
- Mathematics and Science Courses 45
  - Applied Mathematics 45
  - Applied Physics I (Mechanics and Heat) 46

Page
Applied Physics II (Electricity) 48
Auxiliary and Supporting Technical Courses 51
Accounting for Agricultural Equipment Business 51
Agricultural Equipment Technology Seminar I 52
Agricultural Equipment Technology Seminar II 55
Agricultural Equipment Technology Seminar III 56
Drawing, Sketching, and Diagraming 57
Selling, Distributing, and Servicing 58
Technical Reporting 61
General Courses 63
American Institutions 63
Communication Skills 64
General and Industrial Economics 67
FACILITIES, EQUIPMENT, AND COSTS 70
General Planning of Facilities 70
Equipping the Laboratories and Their Costs 80
Summary of Costs 85
BIBLIOGRAPHY 87
Books and Handbooks 87
Reference Periodicals 93

APPENDIXES

A. Selected List of Scientific, Trade, or Technical Societies and Associations 95
B. Occupational Experience Plans and Forms 98
C. Representative Laboratory Experiences 103

THE AGRICULTURAL EQUIPMENT INDUSTRY

THE INTENSIVE APPLICATION of science and modern technology to agricultural production has accelerated land preparation, planting, fertilization, cultivation, harvesting, bulk handling, and transportation processes. Mechanization also has created an urgent demand for skilled agricultural technicians to help develop, market, apply, operate, service, and maintain the efficient and specialized machinery now necessary to the agricultural industry.

From 1920 to 1966, tractor horsepower on farms advanced tenfold. Tractors on farms increased from 3.6 million in 1950 to 5.1 million in 1960. This mechanical power doubled the output per man hour between 1950 and 1962. The expanded use of other machines is even more remarkable. For example, in 1942, a total of 25,135 pickup hay balers were used on farms, while in 1960 there were 279,776 balers, an increase of 9.6 times the 1942 rate. As the Nation's population continues to grow, agricultural production machinery will play an even larger role in greater farm productivity.

The machines used on a modern farm represent a major capital investment and require an increased number of skilled, technically competent persons to supply, operate, and service them.

Figure 1.—Modern machinery such as these harvesters is a vital factor in the miracle of agricultural production in America. Highly skilled agricultural equipment technicians are essential to the function and development of agricultural mechanization.

It was estimated that in 1968 at least 25,000 skilled agricultural equipment technicians were needed by the manufacturers and distributors of farm machinery and equipment. At the same time, there was a critical shortage of trained agricultural equipment technicians on the farms.

GENERAL PROGRAM CONSIDERATIONS

The program outlined in this guide has been developed to help meet the intensified need for more skilled agricultural equipment technicians.

In a 2-year period of carefully planned, concentrated study and on-the-job work experience, a student can learn the science, mathematics, basic principles, and technical skills necessary for successful entry into this field. The limited time requirements demand efficient programing. The sequence of courses must insure proper timing of specific subject coverage. Teaching methods must be streamlined to convey maximum information in a short time period. The program described in this guide has been successfully offered at several educational institutions scattered throughout the country.

The objective of the program is to produce a competent agricultural equipment technician capable of working and communicating with equipment specialists and production personnel, and of growing into positions of increasing responsibility.

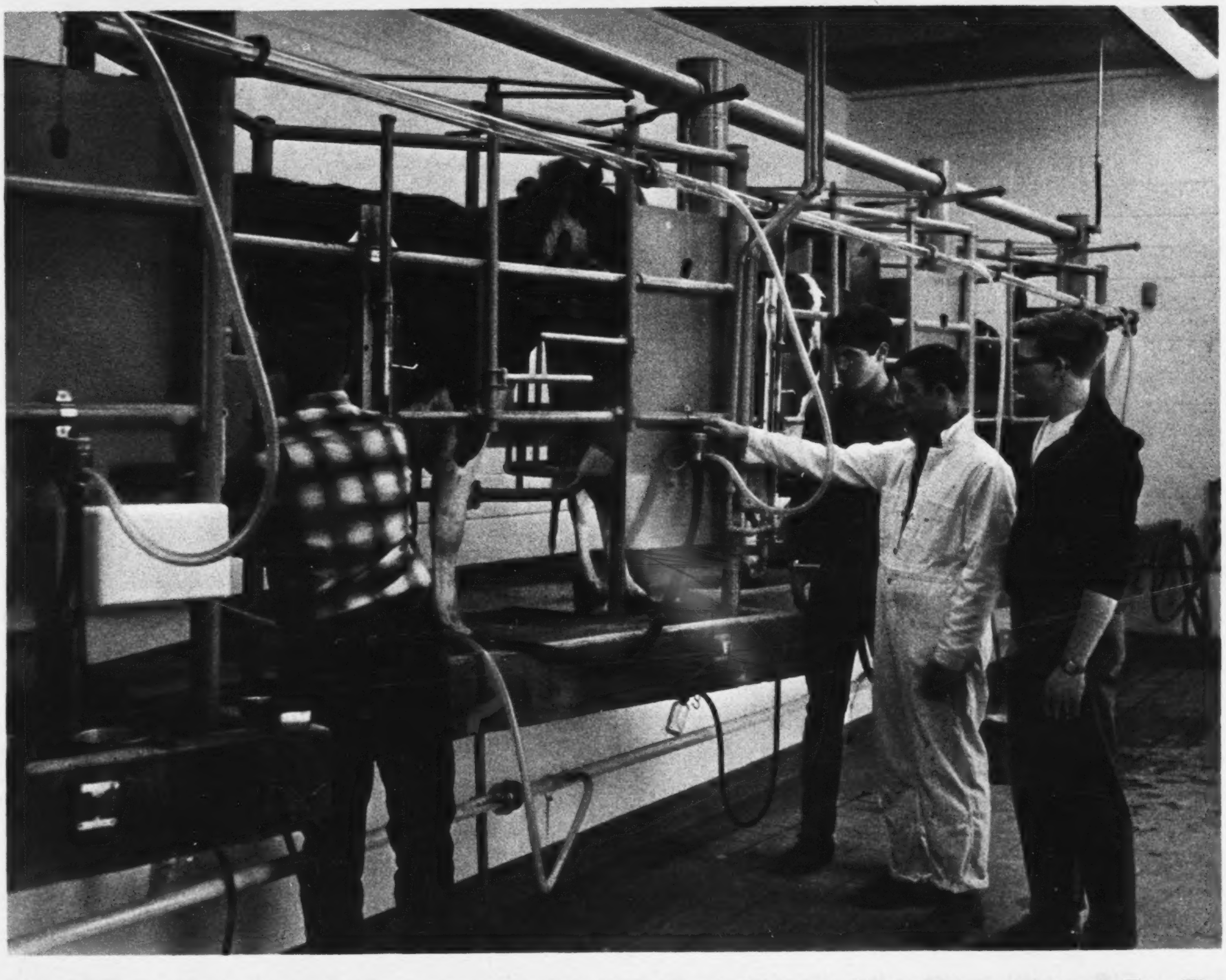


Figure 2.—Highly sophisticated mechanization removes the drudgery from most agricultural production and reduces product costs. The milking parlor shown here is an example of a system of farm equipment which agricultural equipment technicians must understand, operate, and maintain.

The technical content of the program is designed to provide a wide background in using agricultural equipment. In the first year, the student is introduced to scientific principles relevant to this technology, and he makes a specific study of different types of equipment. The second year is based on the first, and a summer's work experience; the information introduced concerns harvesting equipment, tractor transmissions and final drives, hydraulic equipment applications, farm power and power units, and principles of farm mechanization. Agricultural equipment marketing, service, operation, maintenance, and adaptation are stressed because competencies in these areas are needed both by technicians working in agricultural production and by those employed by dealers or distributors of farm machines.

Graduates of this program can expect to find employment in many areas of agricultural production and equipment. Each area may offer slightly different requirements, and most of the differences can be mastered by on-the-job or part-time study. Following are some major areas of job opportunities for agricultural equipment technicians and examples of the work they may do in each:

1. *Onfarm employment*, as an owner, employee, or contractor engaged in agricultural production. The agricultural equipment technician may work on his own farm, be a member of a family which owns or operates a farm, or be employed to work on a farm operated by a family, cooperative, or corporation. He may work for owners of agricultural equipment who may or may not operate farms, and who contract ("custom") planting, spraying, crop dusting, harvesting, land leveling, irrigating, and other special mechanized services. Examples of onfarm agricultural equipment technician employment include:
    a. Owner and operator of the farm and the equipment
    b. Contractor of services requiring equipment
    c. Supervisor of mechanical operation
    d. Supervisor of contracting operation
    e. Technical specialist for particular kinds of equipment
    f. Supervisor of machinery servicing, operation, and maintenance
    g. Farm mechanical specialist
    h. Contract ("custom") operator and manager
2. In the *agricultural equipment industry*, as a manufacturer's representative, as part of a dealership or distributorship, as an owner, or as an employee. Examples:
    a. In a manufacturer's research, development, or sales department:
        (1) Unit or systems tester
        (2) Field testing technician
        (3) Equipment demonstrator and troubleshooter
        (4) Equipment salesman
        (5) Equipment parts and service specialist
        (6) Field service technician
        (7) Equipment application specialist
    b. In a distributor or dealer sales department:
        (1) Sales manager—dealership, branch, or local
        (2) District manager—dealership, branch, or local
        (3) Farm equipment salesman—dealership, branch, or local
        (4) Industrial salesman—dealership, branch, or local
        (5) Farm mechanization salesman—dealership, branch, or local
        (6) Lawn and garden equipment salesman
    c. In a distributor or dealer service department:
        (1) Service supervisor—dealership, branch, or local
        (2) Company or distributor service representative
        (3) Serviceman and equipment specialist
        (4) Diesel serviceman
        (5) Hydraulics serviceman
        (6) Farm mechanization serviceman or specialist
        (7) Setup and delivery serviceman
    d. In a distributor's or dealer's parts department:
        (1) Parts supervisor—dealership, branch, or local
        (2) Parts salesman—dealership, branch, or local
        (3) Partsman
        (4) Warehouse supervisor
        (5) Warehouseman

These listed jobs are merely a sample of the many employment opportunities for skilled agricultural technicians. Because of the variety and specialization in the field, the well-prepared technician must possess certain abilities, scientific knowledge, and technical skills.

Special Abilities Required and Activities Performed by Agricultural Equipment Technicians

There are five special abilities[1] requisite to the performance of any agricultural technician's job, and 12 possible activities which, singly or in combination, define a particular type of technician. Abilities to be mastered by all technicians are:

1. Proficiency in employing the scientific method in physics, chemistry, and/or the biological sciences as they comprise the base for the individual's field of technology.
2. Facility with mathematics; this should include the ability to use algebra and trigonometry, and the ability to understand (although not necessarily facility in the use

Figure 3.—Agricultural machinery employs most of the known mechanical and control systems. Equipment technicians must be taught the underlying scientific principles of the function of multi-system machines such as the farm tractor with earthmoving attachments shown here.

---

[1] Adapted from U.S. Department of Health, Education, and Welfare, Office of Education, *Occupational Criteria and Preparatory Curriculum Patterns in Technical Education Programs*, OE-80015, Washington: U.S. Government Printing Office, Superintendent of Documents, 1962, p. 5.

of) higher mathematics, according to the requirements of the technology.

3. Familiarity with materials, machinery, processes, apparatus, procedures, equipment, operation, and methods commonly used to provide the specialized services of the technology.
4. Extensive knowledge of the field of specialization, with an understanding of the physical or biological sciences as they relate to the engineering, agricultural, or industrial processes that distinguish a particular technology. This knowledge will enable the individual to establish rapport with professional personnel and to exercise individual judgment in his technical and operational areas.
5. Skill in graphic, oral, and written communication, including reading comprehension.

The agricultural equipment technician will use the five special abilities as he performs some or all of the following activities. It is the combination of these activities that defines the technician's field of specialization and course of study. Some of the activities are broadly inclusive; others describe very specific job functions. The technician may:

1. Apply physics and mathematics in the operation and use of engines and farm equipment.
2. Analyze and interpret information obtained from testing devices used on farm tractors and equipment, thus making required evaluations based on charts accompanying the equipment and information found in operator's manuals.
3. Evaluate and estimate values of machines to be traded for new equipment, adapt machinery sizes to particular farming operations, appraise the production potential of a farming operation, and assist in planning, installing, and operating farm mechanization systems.
4. Determine when parts need replacement; use precision measuring devices to determine amounts of wear on old parts and to position new parts.
5. Locate malfunctions in machines and make the most economical repairs.
6. Modify existing machines to perform special jobs when a specialized machine does not exist.
7. Demonstrate machines to potential buyers, show operational features to new purchasers, operate machines as an owner or contractor.
8. Apply knowledge of machines and good business practices in ordering, displaying, and selling parts for farm equipment and tractors.
9. Advise regarding the operation, maintenance, and repair of farm equipment or complex agricultural research apparatus with extensive control systems.
10. Advise, plan, and estimate costs as a manufacturer's representative or distributor.
11. Plan production using agricultural equipment as a member of the management unit responsible for efficient use of manpower, materials, money, and machines.
12. Make independent decisions after analysis and diagnosis of agricultural units or systems. Judgment requires substantive experience in the occupational field as well as scientific and technical knowledge.

The foregoing activities neither exclude nor include functions or activities that might be considered the special prerogatives of recognized professional or skilled worker groups. The technician must be familiar with the work of the professional scientist or engineer and the skilled craftsman or trained laboratory worker in his technical field since he may work with any of them in performing his duties. Few, if any, technicians perform all 12, but the work of all technicians requires some combination of them.

The five general abilities required of all technicians provide a framework which defines the level of competence being exercised when a technician performs some combination of the above 12 activities. The definition of any particular type of technician and the program required to educate him, may be described in terms of what he does (which of the 12 activities he performs) within the context of the quality or level of ability prescribed. The combination of abilities and activities *are criteria* for defining both the type of technician and the education program required to prepare him for beginning employment in his technical field.

A 2-year program must concentrate on primary or fundamental needs if it is to prepare individuals for responsible technical positions in modern industry. It must be pragmatic in its approach and must involve a high order of specialization. The program suggested in this publication has been designed to provide maximum technical instruction in the time that is scheduled.

To those who are not familiar with this type of educational service (or with the goals and interests of students who elect it), the technical program often appears inordinately rigid and restrictive. While modifications may be necessary in certain individual institutions, the basic structure, rigor, and content of this program should be maintained.

The specialized technical courses in agricultural equipment are laboratory and field oriented. They provide application of the scientific principles being learned concurrently in the physics and mathematics courses. For this reason, mathematics and science courses must be coordinated carefully with technical courses at all stages of the program. This coordination is accomplished by scheduling mathematics, science, and technical courses concurrently during the first two terms—a principle that will be illustrated at several points. General education courses constitute a relatively small part of the total program. It has been found that students who enter a technical program do so because of the depth of specialization that the program provides. Nonetheless, many students who elect this type of program will bring to it a background of general study.

Faculty

The effectiveness of the program depends largely upon the competence and enthusiasm of the teaching staff. The specialized nature of the curriculum requires that teachers of agricultural equipment subjects have the special proficiencies characteristically required of those working in the field. All members of the faculty must understand the goals, educational philosophy, and unique requirements that characterize this kind of educational program. They must have a thorough understanding of agricultural machinery units and components, construction, operation, maintenance, and applications in systems of farm mechanization.

To be most effective, members of the faculty responsible for this program must have interest and capabilities which transcend their area of specialization. All faculty members should be reasonably well oriented in the requirements for study in agricultural equipment technology and its applications so that they may use agricultural equipment examples or subject matter as supporting material in their respective courses. For example, if the communications courses are to be of maximum value, the teacher should be familiar with the communications problems and demands placed on agricultural equipment personnel. Without such a background, the communications course work may not offer the support that is needed in the total program of education for technicians. Similarly, various scientific principles may be taught in physics, mathematics, and drawing courses by each of the respective course instructors, emphasizing and illustrating how the principles of applied design and application are used in agricultural equipment.

Teachers of specialized subjects require advanced technical training and practical experience. Recent experience has shown that agricultural equipment technology graduates who have acquired suitable employment experience and who have continued their technical education often become excellent teachers in this type of program. Persons with this background are more likely to understand the objectives, values, and unique instructional requirements of technical education and often bring to the program the enthusiasm and appreciation of the values of technical education that are essential to the success of the program.

Prior satisfactory teaching experience is also highly desirable, and a significant portion of the faculty must have had relevant and reasonably recent employment experience involving agricultural equipment.

A minimum of two and usually three (full-time equivalent) faculty members is required to teach the technical speciality courses in an agricultural equipment technology curriculum, recognizing that entering classes of 25 to 35 students can be taught in lectures, but need to be divided into two sections of 12 to 17 for laboratory work. One specialist usually is designated to head the program. He must be technically competent in all phases of the technology and be capable of providing the necessary leadership in student selection, graduate placement, and in the coordinative departmental teaching effort which will develop completeness and excellence in the program. The other should preferably be full-time faculty members. The department head and at least one agricultural equipment instructor must be employed during the first year of operation of the program. All three specialists (and perhaps more) will be needed during the second and subsequent years.

Sufficient staff to teach the communication skills, technical reporting, mathematics, basic science, and general courses in the curriculum to the agricultural equipment technicians may already be in the institution, but care must be taken to provide sufficient teaching capacity in these subjects without overloading the staff.

Since the programs for highly skilled technicians must consist of a series of well-integrated courses in order to attain the scope and depth of adequate training, careful consideration must be given to when and at what level a new concept is to be introduced. This may be accomplished through the organization of the technical staff into a coordinated teaching unit. Teaching assignments are made on the basis of the individual member's training and talents. Concurrent courses are closely coordinated by team members to best utilize the student's time while he progresses to higher levels of understanding.

Coordinated teaching can be developed and nourished only by the teaching faculty. A weekly departmental staff meeting to insure coordination is recommended. At these meetings each instructor should check with instructors of concurrent courses to insure that course coordination is being maintained. This is especially important when new courses or new techniques are involved and where, if less than optimum coordination is evident, the important factors can be analyzed by those involved and a solution to the problems found quickly.

Staff meetings should provide time for free exchange of ideas on teaching techniques discovered to be useful, and on recently developed laboratory projects which seem to be particularly successful. Any project which appears especially interesting and beneficial to the student should be analyzed to see if the same principles of presentation can be employed in developing other projects. Special attention should be given to any scientific or technical journal articles that may improve the teaching of a subject area or which present new information for teaching.

To keep a staff effective, faculty members should be encouraged to participate as active members of professional and technical societies, and associations related to their field of specialization. Membership in such organizations will acquaint them with the newest literature in the field and help them to maintain close liaison with employers of technicians and leaders in the field by attending meetings addressed by leading specialists. Self-development is being increasingly encouraged by school administrators in the form of released time and financial assistance for instructors to attend technical society meetings and special technical teacher training institutes. Periodic or sabbatical leaves give staff members opportunities to increase and update their industrial experience and to pursue advanced studies.

To be fully effective, the teaching staff must have a limited number of contact hours with students in formal class work. Fifteen to 20 contact hours of classroom or laboratory instruction per week constitute a full teaching load for the technical teacher. The remainder of his time should be devoted to counseling students, further development of courses, creating teaching aids, and setting up laboratory experiences. Consideration also must be given to the number of students in classes. Lecture sections may be somewhat larger than laboratory sections; but, if demonstrations employing pieces of equipment are used, or if the blackboard or opaque projector is used extensively, the lecture class should not exceed 30 students.

The number of students in laboratory sections must also be limited if high quality instruction is to be maintained. Twelve to 17 students in a laboratory section should be considered optimum for the maintenance of a high degree of achievement. For maximum efficiency and the development of individual initiative, work groups within the laboratory usually should be limited to two students.

In order to effectively utilize the capabilities of highly trained faculty, supporting personnel with less training may be employed to develop teaching aids, to keep the laboratory facilities functional, to maintain equipment, and to aid in grading papers. The employment of these assistants, whenever and wherever needed, allows the teaching staff more time for the development and improvement of course materials and promotes better teaching.

Student Selection and Services

While the effectiveness of a technician education program depends greatly upon the quality of the faculty, student selection is equally important. Only well prepared, highly motivated and qualified students will successfully complete this curriculum, obtain employment as beginning technicians, and grow into larger responsibilities. They must *want* to work in this field and recognize the need for extensive technical training to achieve success in the agricultural equipment industry.

Students admitted to the program should be high school graduates or equivalent, with *at least* 1 year of high school mathematics and 1 year of physical science with laboratory instruction. Farm background and/or vocational agricultural training is desirable but not required. Previous experience with agricultural equipment would be valuable to entering students, since it would deepen their appreciation of the complexities of such equipment and contribute to their recognition of the need for a thorough knowledge of how machines function. If students have marked academic deficiencies, they should remove them by some sort of pretechnical remedial study program, preferably at the same school offering the technical program.[2]

The curriculum is designed for high school graduates with special interests and capabilities who can think in an orderly, logical manner. They must be capable of visualizing specific mechanical problems peculiar to the equipment studied, and they should possess the ability to analyze, diagnose, and recognize machine function and performance in their work with the various types of machinery. A reasonable degree of maturity and seriousness of purpose and enthusiasm for their technical specialty is required if they are to fully master a difficult program and develop their capabilities to the maximum in the time available.

Upon arrival at the school, the new student should be familiarized quickly and thoroughly with his new environment and its rules of conduct. His orientation should include an introduction to and familiarization with the library, laboratories, and equipment. Field trips to various equipment organizations and farms might be arranged in order to acquaint the student with the scope and needs of the field. Carefully planned field trips may aid in motivating the students and in demonstrating certain objectives to be pursued in the course work.

Effective guidance and counseling is essential to the agricultural equipment technology program. The student needs direction in discovering educational and employment opportunities consistent with his abilities and interests. Any available entrance tests which identify special abilities or aptitudes should be employed. If a lack of interest or ability to succeed becomes apparent at any time, the student should be advised to review his objectives and perhaps enter another program.

A departmental club may be formed which will strengthen relationships among the students and develop leadership potential and skill in working with people. This type of organization provides an opportunity for students with similar interests to select and discuss areas about which they would like further information. It also provides an opportunity for them to choose their own speakers. The departmental club should be for and directed by the students, but faculty assistance and advice must be available whenever needed.

Experience as an employed worker in the agricultural equipment industry or on the farm is strongly recommended as a part of the student's educational program. The most desirable means of incorporating such experience in the program is a cooperative arrangement between the school and an agricultural equipment or a farming enterprise. A farmer or employer in the agricultural equipment industry and the educational institution should plan a work program designed for a prescribed period of time (one or more semesters or at least a summer) and supervised by a faculty member representing the technology. Under such a plan, the student is expected to be a satisfactory, paid employee and to make reports to the school of his learning experiences on the job. (See appendix B for work experience employment agreement and materials which assist in evaluation of the work experience.)

---

[2] See publication, U.S. Department of Health, Education, and Welfare, Office of Education, *Pretechnical Post High School Program, A Suggested Guide* OE 80049, Washington: U.S. Government Printing Office, Superintendent of Documents, 1967.

If planned cooperative employment is not provided for the student technician, other work experience in his field is strongly recommended. The student often can gain this experience in the summer between his first and second year of study.

Students' academic achievement should be recognized in some manner. Many institutions grant an associate degree upon graduation as tangible recognition of accomplishment.

Graduates of technical programs should be aided in every possible way to find suitable employment. Placement personnel should be aware of industry's needs for agricultural equipment technicians and should acquaint prospective employers with the qualifications of graduates. The placement function is an extremely valuable service to the students, the institution, and the employers. Placement of graduates is ultimately the concern of the department head and the members of his staff who teach the technical specialty courses. An excellent placement record is important in attracting new enrollees. The school should conduct periodic followup studies of its graduates to determine their progress and to evaluate their training. Often this information can indicate how the curriculum or teaching techniques could be improved.

Farm and Laboratory Equipment and Facilities

A school farm or other available cropland, preferably adjacent to the school laboratories and agricultural equipment shops, is requisite. The farm should be owned and operated by the institution; however, if ownership is not feasible, long term leasing may provide this necessary facility. Size of cropland may vary, but there should be at least enough to illustrate how crops are produced and to provide opportunities for students to operate the machinery used in all stages of crop production. The program will thus illustrate the function and application of a wide variety of components, devices, units, and systems, and it also will provide experience in the use, adjustment, and evaluation of the performance of equipment.

Laboratory equipment and facilities are indispensible if the training objectives are to be met. They are a major element in the cost of the program. Laboratories and shops must meet high standards, *for only when they do can they provide a wide variety of valid experiences of practical application.* In order to educate agricultural technicians successfully, the institution must have well-equipped laboratories and sufficient facilities to permit each student to perform all of the laboratory and field work.

Equipment must be of good quality. Inferior or

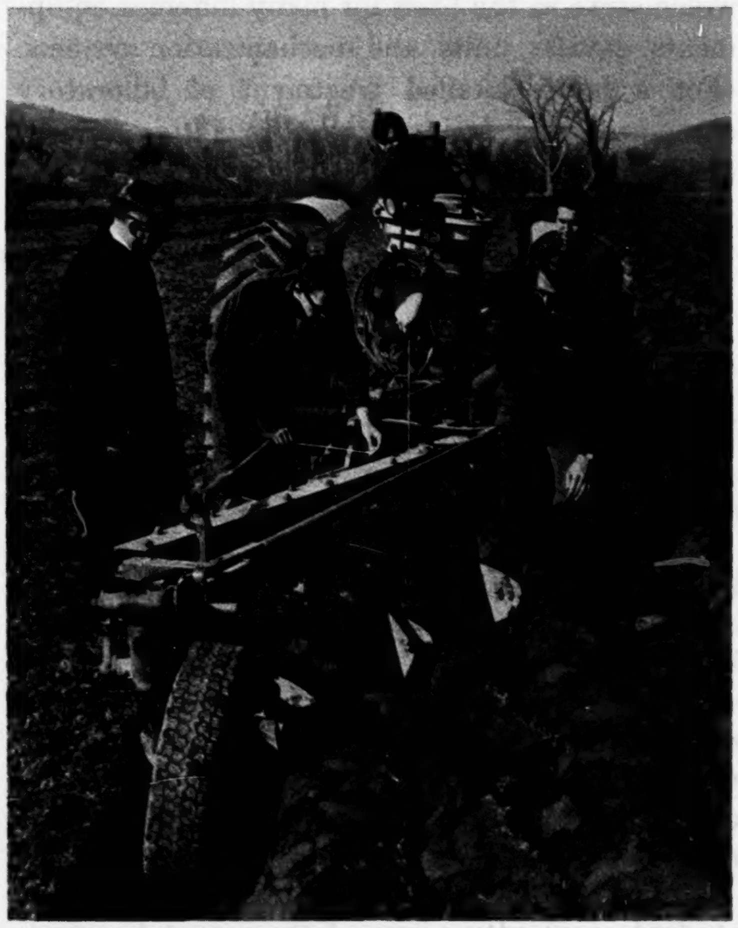


Figure 4.—A class of agricultural equipment technicians learning the operation of mechanical plowing equipment. They study such factors as the effects of different depths of plowing, variations in hitch of plow to tractor, soil condition, speed of tractor, and other related factors.

obsolete equipment may not show the principles being studied or may not be sophisticated enough to provide an up-to-date learning experience. Repairs or adjustments may require unreasonable amounts of time and money. Although the initial cost of high quality equipment is usually greater than that of low quality, the difference in cost is justified by the precise demonstration of principles.

In the selection of laboratory equipment, the need for each item should be well established. Expensive apparatus may not always be required. Many significant experiments can be built around relatively inexpensive components. In fact, simple machinery can, in many cases, make the principles more evident because it represents only the essentials. The number of units purchased, the particular area of interest, the particular industry emphasized, and the instructor's ingenuity in adapting equipment to teaching needs are very important factors to be considered in the selection and price of laboratory equipment. Throughout the program, emphasis should be on the principles which serve as the basis for many different equipments, devices, units, and mechanization systems. (For a more detailed treatment of laboratory equipment and facilities see "Facilities, Equipment, and Costs.")

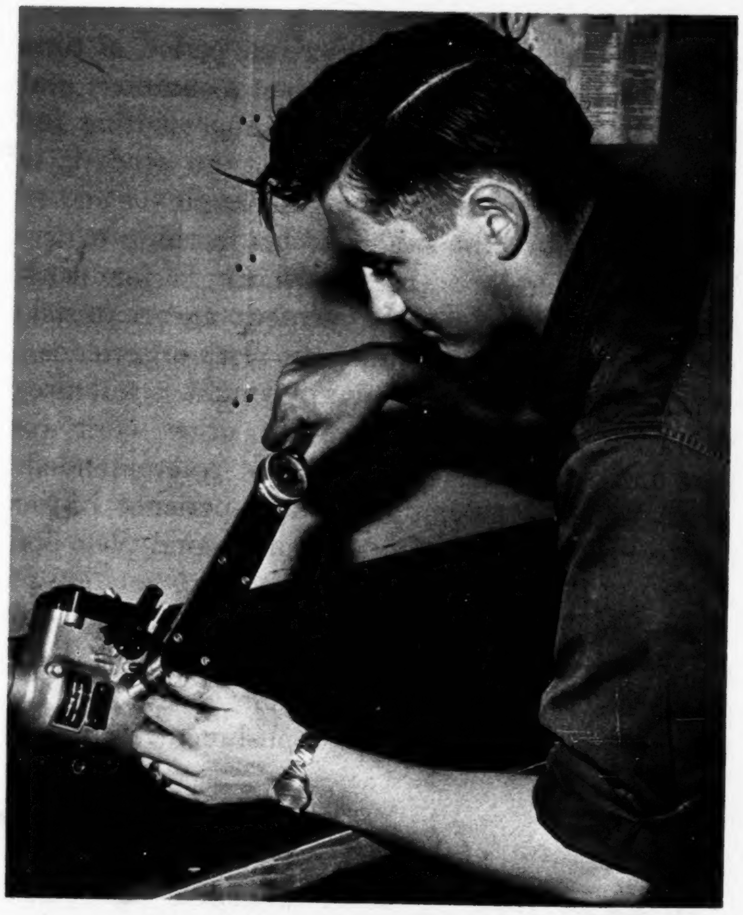


Figure 5.—Agricultural equipment technology laboratories must include a wide variety of precision measuring equipment. The torque wrench shown here is an example of necessary specialized equipment which must be available so every student can learn how it works and practice using it.

Library

In any evaluation of a technology teaching program, a tangible indication of its strength is shown by the following: the qualifications of the librarian; the library facilities; the quality, quantity, and relevancy of content; and the staffing and organization of the library.

Dynamic developments causing rapid changes in technological science and practice make it imperative that the student of any technology learn to use a library. Therefore, instruction for technology students should be library-oriented so that they learn the importance of being able to find information relative to any of the various courses they are studying and form the habit of using the library as a tool in the learning process.

Instructors of all courses should keep the student constantly aware of the extent to which library use is a part of the study in his curriculum. Assignments that require the student to use the library to prepare reports on pertinent subjects in his courses will enable him to understand the resources available and their relation to his technology. Open book examinations that require the use of the library provide excellent and objective experiences for the students. Under the incentive of the examination and the pressure of time, an understanding of his own competency in library skills becomes clear to each student.

The growth and success of the graduate technician will depend largely on his ability to keep abreast of changes in his field. For these reasons a central library under the direction of a professional librarian is important to the success of the technology curriculum. Most instructors have provate libraries in their offices from which they may select books of special interest in their personal conferences with students and thereby stimulate interest in related literature. However, a central library under the direction of a professional librarian insures the acquisition and cataloging of the library content according to accepted library practices and provides accessible location of reference materials by the use of systematic card files. It also provides a system for lending books to students in a controlled and orderly manner typical of a library which an employed technician might use later in solving a technical problem.

Study space with suitable lighting and freedom from outside distractions should be provided in the library for the study of reference data, and provisions for loaning reference materials for out-of-library use should be systematic and efficient.

The contents of a library must adequately provide the literature encompassed by all subjects in a curriculum and extend somewhat beyond the degree of complexity or depth encountered in classroom activities. Literature dealing with highly specialized aspects of a subject may be acquired as needed or may be borrowed by the librarian from more comprehensive libraries.

The teaching staff should actively cooperate with the library staff concerning what materials are to be acquired, and should be responsible for the final selection of the materials that support their technical courses. They must take the initiative in recommending materials to keep the library content current, pertinent, and useful. The library staff should supply the teaching staff with a periodic list of recent acquisitions complete with call numbers. Technical, trade, and association journals and magazines related to agricultural equipment technology are a very important part of the library content for the program.

In addition to reference materials, journals, and trade or association publications, a library should have encyclopedias available for quick reference and should maintain index materials such as the Engineering Index to aid staff and students in finding recent material on specific subjects.

Visual aid matters may be centered in the library. Visual aids should be reviewed and evaluated by both the librarian and a member of the teaching staff as they become available. This procedure will inform the teaching staff regarding the visual aids that are available and where they may be used in the technical programs. Visual aids should always be previewed and analyzed for timeliness and pertinency before being used in a teaching situation.

A well-equipped modern library should have some type of duplicating service available. Such a service allows both students and staff to build up-to-date files of material appropriate to the courses in a curriculum. The service should be available to the students at a minimum cost and free of personal cost to the teaching staff.

Scientific and Technical Societies

Faculty members find that trade associations and scientific and technical societies[3] are important sources of instructional materials and other benefits for themselves and students. Through their publications and meetings, such organizations provide immediate reports and continuing discussion of new concepts, processes, techniques, and equipment related to their technologies. Their presentation of scientific and technical discoveries illustrates the relationship between the theoretical scientist's work and the applied science practitioner's requirements. Their usefulness in keeping up with new developments in a particular phase of science is invaluable.

Less conspicuous than this assistance, but extremely important, is the support which societies may offer in the following areas: (1) Helping to develop evidence of need for a program, (2) promoting the program, (3) enlisting members' support for the program, (4) providing work experience for students, and (5) arranging placement of graduates.

Associations and societies may supply resource people to speak to classes. They may also serve as hosts to student groups on field trips to study specific phases of the industry.

Instructors should be encouraged to become active members in these societies, so that they may learn quickly about new technological developments. Membership will enable them to meet people in the community who are most actively interested in the field. In order to encourage staff participation in selected societies, some educational institutions pay all or part of the costs of membership dues and attendance at local or national meetings.

---

[3] See *Scientific and Technical Societies Pertinent to the Education of Technicians* (OE 80037). Washington: 20402, Superintendent of Documents, U.S. Government Printing Office, 1966.

Early in their studies, students should be required to become acquainted with the literature and services of the major scientific and technical societies and associations related to their technology. They should also be encouraged to join those which offer student affiliate memberships.

The following is a selected list of societies and associations important to agricultural equipment technology:

American Association for Agricultural Engineering and Vocational Agriculture
American Society of Agricultural Engineers
American Society of Certified Engineering Technicians
American Society for Engineering Education
American Society for Testing and Materials
American Standards Association
American Technical Education Association
American Welding Society
Automotive Electrical Association
Diesel Engine Manufacturers Association
Edison Electric Institute
Farm and Industrial Equipment Institute
Farm Equipment Manufacturers Association
Fluid Power Society
Ignition Manufacturers Institute
Institute for the Certification of Engineering Technicians
Joint Industrial Council
National Farm and Power Equipment Dealers Association
National Fluid Power Association
National Safety Council
Outdoor Power Equipment Institute
Society of Automotive Engineers

See appendix A for a more detailed listing.

Advisory Committees and Services

The success of technician education programs depends greatly upon the formal and informal support of advisory committees. When an institution considers initiation of a particular program, the chief administrator or dean should appoint an advisory committee.

The special advisory committee for the agricultural equipment technology program should include representatives of employers, public employment services, scientific or technical societies and associations in the field, and interested civic leaders. These people work with and advise the specialists on the school staff. Such committee members serve without pay, as interested citizens. They enjoy no legal status for this service but provide invaluable assistance. The committee normally consists of about 12 members (but may vary from six to 20), who generally serve for 1 or 2 years. The head of the institution or the department head of the technology is ordinarily chairman. It should be remembered that such people are always busy; therefore, meetings should be called only when committee action is the best means of handling a specific task or problem.

The committee assists in surveying and defining the following areas: need for technicians; knowledge and skills required of technicians; opportunities for employment; available student population; curriculum, faculty, laboratory facilities, and equipment; cost and financing of the program. When the studies indicate that a program should be initiated, the committee's help in planning and implementing it is invaluable.

Frequently, the committee gives substantial help to school administrators in obtaining funds and securing State and Federal support for the program. When the graduates seek employment, the committee helps to place them in jobs and to evaluate their performance. These evaluations will often result in modifications in the program to make it relate more closely to employment requirements.

This publication is designed primarily for planning and developing a full-time preparatory program in post high school institutions. The advisory committee can use it as a starting point, modifying it to meet local needs. The program also can form the basis for courses which will meet the requirements of employed adults who wish to upgrade their skills and technical capabilities. In this way, the school administrator, with the help of the committee and special consultants, can effectively initiate the needed program, quickly develop it to a high level of excellence, and maintain its timeliness.

THE CURRICULUM

Curriculum Outline

	Hours per Week			
First Semester	*Class*	*Laboratory*	*Outside Study*	*Total*
Communication Skills	3	0	6	9
Drawing, Sketching, and Diagraming	1	2	2	5
Planting and Tillage Equipment	2	6	4	12
Welding I (Elementary)	0	4	0	4
Applied Physics I (Mechanics and Heat)	2	4	4	10
Applied Mathematics	4	0	8	12
Agricultural Equipment Technology Seminar I	1	0	2	3
	13	16	26	55
Second Semester				
Technical Reporting	2	0	4	6
Agricultural Chemical Equipment	2	4	4	10
Accounting for Agricultural Equipment Business	3	0	6	9
Farm Power I (Gas Engines)	2	4	4	10
Hydraulics I (Basic)	2	2	4	8
Applied Physics II (Electricity)	2	4	4	10
	13	14	26	53
Summer Session—Occupational experience in the agricultural equipment (or related) field				
Third Semester				
Agricultural Equipment Technology Seminar II	1	0	2	3
Welding II (Advanced)	1	4	2	7
Principles of Farm Mechanization	3	6	6	15
Transmissions and Final Drives	2	4	4	10
Harvesting Equipment	2	4	4	10
General and Industrial Economics	3	0	6	9
	12	18	24	54
Fourth Semester				
Agricultural Equipment Technology Seminar III	1	0	2	3
Hydraulics II (Equipment Applications)	2	4	4	10
Selling, Distributing, and Servicing	3	2	6	11
Farm Power II (Diesel)	2	4	4	10
Power Unit Testing and Diagnosis	2	4	4	10
American Institutions	3	0	6	9
	13	14	26	53

Brief Description of Courses

FIRST SEMESTER

Communication Skills

A course designed to promote greater competence in reading, writing, talking, and listening.

Drawing, Sketching, and Diagraming

A course designed to develop illustrative and graphic communication skills, with emphasis on presenting information effectively by using diagrams, drawings, prints, sketches, graphs, and charts drawn freehand and by means of commonly available drawing aids such as straight edges, curves, squared or graph paper.

Planting and Tillage Equipment

A course in selection, application, and operation of planting and tillage machinery. It includes experimental checking and study of operational speeds, rated capacity, and power requirements of a variety of machines, both in the field and in the laboratory.

Welding I (Elementary)

A course to acquaint students with the equipment used in welding and cutting mild steel and cast iron, and to teach students some skill in welding in the flat, vertical, and overhead positions.

Applied Physics I (Mechanics and Heat)

A study of the basic principles of physics emphasizing mechanics and heat, with particular attention to applications of those principles in agricultural equipment.

Applied Mathematics

A course in mathematical problems commonly encountered in agricultural equipment technology. It includes a review of arithmetic and a study of elementary geometry and trigonometry, fundamental business calculations, use of the slide rule, and solutions of typical agricultural equipment problems.

Agriculural Equipment Technology Seminar I

The first of a three-part course designed to acquaint the student with his educational institution and the opportunities open to him in the agricultural equipment industry.

SECOND SEMESTER

Technical Reporting

A study of effective ways of presenting information. The student learns to use illustrations and outlines for various types of oral and written, formal and informal reports. Conciseness, accuracy, and form are emphasized.

Agricultural Chemical Equipment

A course to provide the student with the knowledge and understanding needed to select, operate, adjust, service, maintain, and repair equipment used in the application of agricultural chemicals.

Accounting for Agricultural Equipment Business

An introduction to the application of double-entry accounting in the agricultural equipment business which provides the student with the fundamentals of accounting theory and practice. The use of accurate accounting data in making business decisions is illustrated by studying appropriate agricultural equipment and farm production businesses problems.

Farm Power I (Gas Engines)

The first in a sequence of courses on farm power. It is a study of internal combustion engine principles and the diagnosis, service, and repair of farm machinery and tractors.

Hydraulics I (Basic)

An introductory course designed to develop an understanding of the principles of fluid power. The technical language, principles, components, and systems of hydraulic units, and their applications, are studied.

Applied Physics II (Electricity)

A study of basic electrical principles and their application to agricultural equipment. Types of electric motor controls, wire sizes and types, grounding, and planning and installation of various types of circuits are studied.

THIRD SEMESTER

Agricultural Equipment Technology Seminar II

A continuation of *Agricultural Equipment Technology Seminar I*. The course includes study of methods of applying for and adjusting to a new job, the roles of supervisors and managers, and the organizational, legal, and business aspects of an agricultural equipment enterprise or farm production unit.

Welding II (Advanced)

A continuation of *Welding I*. The course extends the study of welding different types of metals. Students learn about and develop some skill in inert gas welding. Each student plans, builds, and tests a welded mechanism as a special project for the course.

Principles of Farm Mechanization

An elementary course in planning efficient farm buildings, functional equipment layouts, and efficient flow of materials within the buildings. Local farms are studied for practical application of the principles covered.

Transmissions and Final Drives

A study of the fundamentals and principles used in power transmissions as applied in wheel and crawler tractors, a logical course to follow *Farm Power I* (Gas Engines).

Harvesting Equipment

A course in selection, operation, adjustment, and use of farm harvesting machines. Field operation is required to study performance of machines in terms of design, operating speeds, and variations in ajdustment. Careful integration of field and laboratory work is required to enable students to learn to use testing devices and to develop the ability to analyze machine performance.

General and Industrial Economics

A study of general economic principles to provide students with an understanding of the relationship of cost control to successful business operations and to aid students in planning their personal finance programs.

FOURTH SEMESTER

Agricultural Equipment Technology Seminar III

A continuation of *Agricultural Equipment Technology Seminar II* and the final course in the sequence. An analysis of the facilities and equipment needed for an agricultural production unit and a farm equipment business, the merchandise selection to serve a trade area, and the operation and management of parts and service departments.

Hydraulics II (Equipment Applications)

A continuation of *Hydraulics I*. A course in diagnosis and testing of hydraulic systems and service problems in farm and light industrial equipment. It emphasizes laboratory study of hydraulic circuits, systems, power steering units, and transmissions to identify and correct maladjustments.

Selling, Distributing, and Servicing

An introductory course in modern salesmanship techniques and procedures. It analyzes marketing and product services as they depend on the student's ability to use principles of salesmanship, verbal persuasion, and sensitivity in person-to-person relationships.

Farm Power II (Diesel)

A course in diesel engines emphasizing the underlying principles of the diesel engine, with emphasis on different types of design and construction. It emphasizes laboratory inspection and servicing using special equipment for diagnosing and testing performance of diesel engines and their components.

Power Unit Testing and Diagnosis

A course which applies principles learned in the *Electricity*, *Farm Power*, *Applied Physics*, and *Hydraulics* courses in the analysis of malfunctions of components and their interrelationship with other components in electrical and nonelectrical systems of wheel and crawler tractors.

American Institutions

A course to orient the student to the important social institutions in the society in which he lives. It is an introductory study of political science, American government, labor organizations and institutions, and government programs.

Curriculum Content and Relationships

The sequence of courses in a 2-year program is as important as the content of the courses. In general, the subject matter and courses in this program are carefully correlated so that specialized technical course work is introduced immediately in the first semester. Delay in this introduction, even for one semester, would impose serious limitations on the effectiveness and advantages of the program plan, because:

(1) Student interest is stimulated by practical aspects of instruction. If the first term consists entirely of general subjects—i.e., mathematics, English, social sciences—students often lose interest.

(2) It is possible to obtain greater depth of understanding in specialized subjects in the latter stages of the 2-year program.

(3) Practical applications of mathematics and science are made throughout the technical courses.

In the first semester of this program, the courses supplement each other and provide a basis for study in subsequent semesters. The knowledge and skills learned in *Drawing, Sketching, and Diagraming* are utilized in the same semester in *Planting and Tillage Equipment*, and in courses occurring in later semesters; e.g., *Technical Reporting, Electricity, Hydraulics, Principles of Farm Mechanization*, and *Harvesting Equipment*. Concepts learned in *Applied Mathematics* are used immediately in the *Applied Physics I* (*Mechanics*) and the *Planting and Tillage Equipment* courses. Skills acquired in the welding courses are applied in the repair phase of the machinery courses.

In the second semester, the course in technical reporting provides the students with the skills needed for writing and understanding technical reports and manufacturers' manuals on operating, servicing, and settingup machines. *Applied Physics II* (*Electricity*) provides the scientific background for engine ignition and for electrical systems control of machines in subsequent courses. In addition, knowledge of A.C. and D.C. electricity is necessary for work with tractor electrical systems and in the study of farm mechanization.

Tractors are the most common power source in farm and light industrial mechanization. *Farm Power I* introduces the student to the basic principles of the gasoline engine and to the repair and service procedures for gasoline tractors. *Transmissions and Final Drives* in the third semester emphasizes the principles of operation, repair, and servicing of transmissions and final drives. In the fourth semester, the student studies *Power Unit Testing and Diagnosis*, in which he learns to use various kinds of testing equipment to diagnose tractor malfunctions. More than half the tractors sold in 1966 were diesels, so *Farm Power II* stresses an understanding of diesel principles and methods of repairing and servicing diesel engines and such components as fuel pumps, injector nozzles, and turbo-chargers.

Increasing use of mounted and hydraulically controlled equipment has made hydraulics a vital part of today's farm machinery and light industrial equipment. The basic *Hydraulics I* course, taught in the second semester, presents the principles of hydraulic power. It also provides background for *Hydraulics II* which is studied in the fourth semester. The latter course stresses hydraulics systems in tractors and in light industrial equipment, emphasizing the testing, diagnosing, and correction of malfunctions.

Specific study of farm machinery is divided into two courses, *Planting and Tillage Equipment* in the first semester followed by *Harvesting Equipment* in the third semester. Laboratory work in each course includes field operation and machine adjustments, as well as principles of setting-up and predelivery servicing of machines, analyzing their performance, and making necessary repairs.

Two courses on the business aspects of the farm machinery industry are included in the curriculum. Keeping and interpreting business records and accounts is taught in *Accounting for Agricultural Equipment Business* during the second semester. *Selling, Distributing, and Servicing* is taught in the fourth semester to familiarize the student with principles and techniques of merchandising.

Principles of Farm Mechanization is a survey of materials handling equipment sold and serviced by many farm machinery dealers. The student learns what types of equipment are available and the means of servicing them. The course emphasizes principles of materials handling and power application in mechanized systems used on the farm.

The *Agricultural Equipment Technology Seminar* is included in the program for three of the four semesters. In the seminars the student learns of occupational opportunities for the specialist in agricultural equipment industry, what he must be able to do, and how he may prepare himself for employment in the industry or on a farm.

Since the graduate of this curriculum will assume an active role in society, courses in communication skills, economics, and American institutions have been included. These courses enable the student to become a better informed citizen and to communicate effectively with others.

This curriculum in agricultural equipment technology suggests the hours per week for classes, laboratories, and outside study for each course. The class periods may be used for discussions as well as for lectures, audio visual presentations, and demonstrations.

Laboratory periods for certain courses, such as *Principles of Farm Mechanization*, follow the traditional pattern of practice, study, and evaluation. In other courses, the laboratory time is used to develop skills in operating, servicing, and repairing agricultural equipment. Laboratory periods may also be used for field trips and for other class activities which require more time than is available in the traditional class periods.

Outside study is a significant part of the student's total program. This curriculum presupposes 2 hours of outside study for each hour of scheduled class time. In the limited number of class hours available, the student will not be able to master all of the material presented. Consequently, instructors should make specific outside study assignments to help students master the essential course work. A typical schedule for a student in agricultural equipment technology comprises 53- to 54-hours per week. Although this represents a full schedule, it is not excessive for this type of program.

Although no examinations have been scheduled in the outlines of this guide, it is intended that there be time available for them. Therefore, a 17-week semester is assumed, and the material in the course is to be covered in 16 weeks. The primary objective of examinations is to evaluate the student's knowledge and to stimulate him to make a periodic comprehensive review of the material presented in the courses. The results of the examinations also point out weaknesses in teaching techniques or subject matter coverage

Cooperative Education Plan

This technology is adaptable to a cooperative work study arrangement—a plan which offers important advantages to students, to the school, and to employers of technicians. A cooperative education program is a plan for student learning through coordinated study and employment experience. The student alternates periods of attendance at the institution where he receives his technical education with periods of employment on a farm or in an agricultural equipment business. The student's employment constitutes an essential element in the educational process and should be related as closely as possible to some phase of the field of study in which he is engaged.

When a student tests his school-learned theory in a work situation, study becomes more meaningful. The co-op student learns not only the applied essentials of his technology, but also the importance of reliability, cooperation, and judgment as an employed worker in his chosen field.

The co-op student's career choice is stimulated and shaped by his work experiences. Should he find satisfaction in his work, he returns to the classroom stimulated to learn as much as possible about his future career. Should he find through his work experience that he is not fitted for a specific area of work, he may decide to change his major field of study when he returns to the college. This decision may prevent him from wasting his time and money on a misguided choice of study.

A class of students in cooperative technical programs usually spends the first semester or the first two quarters in school; then it is divided so that half get a semester or quarter of employment experience while the other half continue to study. During the next semester or quarter, the half which worked return to their formal studies at school, while the other half of the class are employed. They usually alternate again so that each student has two semesters or at least two quarters of work experience in his program. *The student's technical program is lengthened beyond the curriculum outlined in this guide by an amount of time equal to the total length of the employment experience.*

Specific employment is obtained, as circumstances permit, by the educational institution, with the cooperation of the student. The institution regards the work-experience program as an integral part of the technician educating program as a whole. It is not regarded primarily as an earning opportunity, although all students are paid at the prevailing wage scale for the job they hold. Work reports by both the student and the employer are submitted to the school work-program coordinator.

The cooperative work-experience program is an opportunity to gain directly related experience which will make the student more desirable as an employee. As a result of their work-experience with a particular establishment, many students have been offered permanent positions with that organization upon completion of their schooling. Cooperating establishments agree, however, not to make offers of employment which become effective before the completion of the technician educating program.

Cooperative programs provide special opportunities for the educational institution to maintain close contact with employers in their various programs. This contact becomes a valuable two-way channel of communication which helps the educational institution to keep its knowledge of specific employer needs in each technical field up to date, and at the same time keeps employers acquainted with and involved in the program of the institution.

Suggested Continuing Study

A 2-year technical program concentrates on the primary needs of, and related knowledge and skills for, employment. A program of this nature cannot cover in depth all the subjects which are pertinent to a particular technology; therefore, continuing study for graduates of technology programs is essential. While reading current literature related to the technology is one method of keeping up with the many developments in the field, it tends to build only upon the technological base provided by the student's previous education. Formal continuation of supplementary courses, however, provides an efficient and practical means of adding important related areas of knowledge and skill to the initial education of the 2-year technical program graduate. These courses offer the advantages of systematic subject coverage, disciplined and competent teaching, and opportunity for class discussion.

Sales and service schools, operated by machinery manufacturers, are regarded as among the best means of learning additional skills and technical information concerning the tractors and other machinery with which the graduate will be working. Most manufacturers periodically conduct schools, either at branch locations or at company training centers. Training programs of this type are especially valuable because they are taught by men who have had extensive experience with the machines they teach about, and because they explain the best sales and service techniques the manufacturer has developed. Since these programs are frequently offered in the evenings or on Saturdays, most persons who need them can avail themselves of these advancement opportunities without infringing on their working hours.

The following are examples of courses which might be included in continuing study for agricultural equipment technology graduates:

Land leveling
Irrigation systems
Surveying
Agricultural chemicals
Mechanical drawing and design
Instrumentation and automatic control
Strength of materials
Business operation analysis
Business record keeping and accounting
Industrial supervision and managment
Public speaking
Federal, State, and local taxes
Personnel management
Business finance
Retail management

COURSE OUTLINES

The following course outlines suggest the content which might be taught in the curriculum. The suggested material provides a practical and attainable coverage of the field; it has been reviewed by experienced instructors in successful agricultural equipment technician programs and by experts representing employers of skilled agricultural equipment technicians.

It is expected that these materials will be modified in some measure to fill the needs defined by local advisory committees and to take advantage of the special interests and capabilities of a particular teaching staff; however, the implied level, quality, and completeness of the program should not be compromised.

At the end of each course is a list of text reference materials. The name of the publisher and the place and date of each publication are shown in the Bibliography. Each publication should be analyzed for its content and pertinence. More suitable ones should be substituted if they are available. The information needed to cover a particular course in technician education programs, particularly the technical specialty courses, is almost never available in one textbook; hence, the multiple listing of references. These references should be considerably augmented by current materials from manufacturers, trade journals, technical societies, and suppliers of equipment, apparatus, and services in the special field of study.

The need to review and supplement textbooks, references, and visual aids cannot be overemphasized in light of (1) the rapid developments of new knowledge in a technical field, and (2) the results of research in methods of teaching basic concepts in the physical sciences and mathematics. This is especially true in the agricultural equipment area. The development of whole new areas of theoretical and applied scientific knowledge creates demand for fresh textbooks, references, articles in scientific and technical journals, and visual aid materials.

New textbooks will reflect recent methods of teaching scientific principles and applications as fast as current research in education becomes applicable. Recent extensive research in methods of teaching mathematics and physics may produce changes in teaching materials and methods. Therefore, it is mandatory that instructors constantly review modern texts, references, and visual aid materials as they become available and adopt them when they are an improvement over those suggested here or those presently in use.

The suggested texts and references have been carefully selected. From the lists presented it should be possible to select suitable ones. However, it should not be assumed that unlisted books are not suitable; there are, no doubt, new or unlisted ones which are excellent.

Before a department head or instructor undertakes a program in agricultural equipment technology, or any course in the curriculum, it is urged that he familiarize himself with the texts and references listed here and others which are available.

Suggested visual aids are listed for many courses. Each should be used when pertinent and when its use will be more effective than any other teaching method. *Excessive showing of films at the expense of well-prepared lectures and demonstrations is to be avoided.* The suggested outside study periods may be used, instead of class lecture time, for the showing of some films. All visual aids should be examined by the instructor before they are shown.

It is expected that the experienced instructor will make liberal use of charts, slides, models, samples, and specimens which illustrate special technical aspects of the subject. These usually are accumulated from the instructor's previous laboratory or lecture preparations, and should be updated regularly. Such aids are too specific to list in this guide.

The laboratory sessions suggested in the program outline and in the course descriptions are not necessarily intended to be a single session but show total hours of laboratory per week to be scheduled in reasonable and effective increments. For example, a 6-hour laboratory total per week might be scheduled as three 2-hour sessions or two 3-hour sessions, or in any other division that seems appropriate.

AGRICULTURAL CHEMICAL EQUIPMENT

Hours Required

Class, 2; Laboratory, 4

Description

This course is designed to provide the student with the understanding, skill, and ability needed to select, operate, adjust, maintain, and repair equipment which is used to apply agricultural chemicals.

Major Divisions

	Class hours
I. Chemicals in Agriculture	6
II. Sprays and Spraying Equipment	8
III. Dusts and Dusting Equipment	4
IV. Fumigants and Fumigation Equipment	4
V. Fogging Equipment	4
VI. Fertilizers and Fertilizing Equipment	6
Total	32

- I. Chemicals in Agriculture
  - 1. Importance of proper application
    - a. Control, eradication, or prevention of pests and diseases
    - b. Plant growth regulators or modifiers
    - c. Nutrients and soil additives
    - d. Physical forms of chemicals
      - (1) Liquid
      - (2) Solid
      - (3) Colloidal materials
      - (4) Solids suspended in liquids
      - (5) Gaseous
    - e. Methods of applying different forms of chemicals
      - (1) Spraying
      - (2) Dusting
      - (3) Spreading solids
      - (4) Fogging
      - (5) Applying gases
  - 2. Chemicals used in agriculture
    - a. Insecticides
    - b. Fungicides
    - c. Nematocides
    - d. Herbicides
    - e. Plant regulators
    - f. Fertilizers
    - g. Soil additives
    - h. Bactericides
    - i. Rodenticides
    - j. Molluscicides
  - 3. Kinds of chemical materials
    - a. Toxic agents
    - b. Safeners
    - c. Spreaders
    - d. Stickers
    - e. Wound dressings
    - f. Repellents
    - g. Baits
    - h. Attractants
- II. Sprays and Spraying Equipment
  - 1. Theory and principles of spraying
    - a. Effect of speed and pressure on amount applied
    - b. Nozzles and nozzle sizes for proper coverage
    - c. Droplet size—effect of pressure and wind drift
  - 2. Equipment
    - a. Types
    - b. Operational principles
    - c. Parts and construction
  - 3. Precautions and safety
- III. Dusts and Dusting Equipment
  - 1. Theory and principles of dusting
    - a. Effect of speed and pressure on amount applied
    - b. Nozzles and nozzle sizes for proper coverage
    - c. Particle size—effect of pressure and wind drift
  - 2. Equipment
    - a. Types
    - b. Operational principles
    - c. Parts and construction
  - 3. Precautions and safety
- IV. Fumigants and Fumigation Equipment
  - 1. Theory and principles of fumigation equipment
    - a. Effect of speed and pressure on amount applied
    - b. Nozzles and nozzle sizes for proper coverage

        c. Droplet size—effect of pressure and wind drift
    2. Equipment
        a. Types
        b. Operational principles
        c. Parts and construction
    3. Precautions and safety

V. Fogging Equipment
    1. Theory and principles of fog applicators
        a. Effect of speed and pressure on amount applied
        b. Nozzles and nozzle sizes for proper coverage
        c. Droplet size—effect of pressure and wind drift
    2. Fog applicators
        a. Types
        b. Operational principles
        c. Parts and construction
    3. Precautions and safety

VI. Fertilizers and Fertilizing Equipment
    1. Theory and principles of fertilizers and use of soil additives
    2. Fertilizing equipment
        a. Types
            (1) Solid
            (2) Liquid
            (3) Gaseous
        b. Parts and construction
        c. Operational principles
        d. Precautions and safety

Laboratory—96 hours

Laboratory experience may be completed concurrently with class discussions of the major divisions, or it may follow them. Through laboratory experience, students become familiar with the types of equipment used in the application of agricultural chemicals in agricultural production. Principles should be stressed. Laboratory study should include field operation, calibration, adjustment, maintenance, repair, and overhaul of the following: sprayers, dusters, fumigators, foggers, and fertilizer and soil additive equipment.

Texts and References

Ace Pumps. Ace Pump Corp.

Agricultural Spray Nozzle Manual. Spraying Systems Co.

Agricultural Spray Nozzle Manual, Industrial Spray Nozzles and Related Equipment. Spraying Systems Co.

Chemical Applicators. Gandy Co.

Delavan Agricultural Spray Equipment. Delavan Manufacturing Co.

Farm Chemicals Handbook. Meister Publishing Co.

GULVIN *and* STONE. *Machines for Power Farming.*

HUNT. *Farm Power and Machinery Management.*

KLINGMAN. *Weed Control as a Science.*

METCALF *and others. Destructive and Useful Insects.*

Monarch Farm Spray Equipment. Monarch Manufacturing Works, Inc.

Noble Chemical Applicators. Noble Manufacturing Co.

SMITH. *Farm Machinery and Equipment.*

FARM POWER I (Gas Engines)

Hours Required

Class, 2; Laboratory, 4

Description

This course is a study of principles of internal combustion engines. Types of engines used in farm, light industry, and garden power applications are studied, together with the design and construction of engine components and systems. Commercial shop management procedures are followed in the diagnosis of problems and the service and repair of farm power units. Safety is emphasized and must be practiced throughout the course.

Major Divisions

	Class hours
I. History and Development of Tractors and Power Units	2
II. Power and Its Measurement	3
III. Internal Combustion Principles	3
IV. Engine Construction and Design	4
V. Fuels and Combustion	3
VI. Carburetion and Carburetors	3
VII. Electrical Systems	3
VIII. Air Cleaners and Cooling Systems	1
IX. Governing and Governors	2
X. Lubricants and Lubrication Systems	2
XI. Minor and Major Engine Repair	4
XII. Small Tractors	2
Total	32

I. History and Development of Tractors and Power Units
    1. Early inventors and tractor development
    2. Engine types
        a. Gasoline
        b. Diesel

   c. LP gas
   d. Gas turbine
   e. Fuel cell
   f. Others

II. Power and Its Measurement
  1. Definitions
  2. Power calculations
  3. Nebraska Tests
  4. Trends in power and tractor sizes
  5. Power losses from accessories

III. Internal Combustion Principles
  1. Thermodynamic principles and their application
  2. Engine cycles and principles of operation
  3. Engine efficiency
  4. Bore-stroke ratio
  5. Compression ratio and displacement

IV. Engine Construction and Design
  1. Engine nomenclature and function
  2. Materials of construction
  3. Crankshafts and firing orders
  4. Engine balance
  5. Valve design, materials, timing, servicing
  6. Combustion chamber design

V. Fuels and Combustion
  1. Types and compositions of fuels
  2. Gasoline test significance
   a. Anti-knock
   b. Octane number
   c. Volatility
   d. Additives
  3. Fuel filters

VI. Carburetion and Carburetors
  1. Carburetion principles
   a. Fuel-air ratio
   b. Fuel and air flow
   c. Starting, idling, and compensating
  2. Types of carburetors
  3. Carburetor adjustment
  4. LP Gas equipment

VII. Electrical Systems
  1. Battery and charging system
  2. Cranking system
  3. Ignition system

VIII. Air Cleaners and Cooling Systems
  1. Clean air
  2. Types of air cleaners
  3. Servicing air cleaners
  4. Types of cooling systems
  5. Servicing cooling systems

IX. Governing and Governors
  1. Principles and systems
  2. Types of governing mechanisms
  3. Servicing governing systems

X. Lubricants and Lubrication Systems
  1. Types of lubricants
  2. SAE and API classification
  3. Additives
  4. Splash and force feed systems
  5. Bearings and bearing lubrication
  6. Crankcase ventilation

XI. Minor and Major Engine Repair
  1. Farm, light industrial, and small gas engines service procedures
   a. Use of service manuals
   b. Use of tools and service equipment
   c. Step-by-step repair procedure
  2. Condition of parts which affect compression; e.g., rings or valves
  3. Conditions which affect oil consumption; e.g., valve guides and rings
  4. Conditions relating to excessive noises; e.g., main or rod bearings
  5. Break-in procedure
  6. Final tuneup

XII. Small Tractors
  1. Types
  2. Makes
  3. Sizes
  4. Accessory equipment
  5. Governors and cooling systems
  6. Lubrication
  7. Troubleshooting
  8. Overhaul

Laboratory—64 hours

Laboratory time should be used for testing, diagnosing, disassembling, inspecting, repairing, and reassembling various engines. Lack of defects is the goal of all repair work. Using tractors and small gas engines furnished by the students or by local dealerships, the overhaul should include power tests (before and after), engine rebuilding, and overhaul of the cooling, lubrication, carburetion, and governing systems.

Texts and References

Barger *and others. Tractors and Their Power Units.*
Brown *and* **Morrison**. *Farm Tractor Maintenance.*
Crouse. *Automotive Mechanics.*

Doctor of Motors: ℞ for Better Gasoline Engine Overhauls. Dana Parts Co.

Doctor of Motors: ℞ for Preventing Oil Loss Through Valve Guides. Dana Parts Co.

Duffy. *Power, Prime Mover of Technology.*

Engine Installation Manual. Internal Combustion Engine Institute.

Farm Tractors. Engineering Bulletin FT–53. American Oil Co.

Frazee and Bedell. *Automotive Fuel and Ignition Systems.*

General Theories of Operation. Briggs and Stratton Corp.

Glenn. *Glenn's Auto Repair Manual.*

Graham. *Audel's Truck and Tractor Guide.*

I & T Shop Service. Technical Publications, Inc.

Jones. *Farm Gas Engines and Tractors.*

Long. *Chain Saw Service Manual.*

———. *Small Engines Service Manual.*

———. *Small Tractors Service Manual.*

Master Service Manual. Tecumseh Products Co.

Service Manual for the Doctor of Motors. Dana Parts Co.

Small Engines Mechanics. Vocational Curriculum Development and Research Center.

Toboldt and Purvis. *Motor Service's Automotive Encyclopedia.*

Venk and Billiet. *Automotive Engines Maintenance and Repair.*

———. *Automotive Fundamentals.*

Wetzel. *Automotive Diagnosis and Tune-Up.*

What You Should Know About Farm Tires. B. F. Goodrich Co.

Manufacturers' operator and service manuals are available through major line branches or distributorships.

Visual Aids

The ABC of Internal Combustion. 13 min., 16mm., sd., color. Film Library, General Motors Corp., General Motors Building, Detroit, Mich. 48202.

Summary: The four-stroke cycle is clearly illustrated along with the fundamentals of valve operation, carburetion, and ignition timing.

The ABC of the Automobile Engine. 18 min., 16 mm., sd., color. Film Library, General Motors Corp., General Motors Building, Detroit, Mich. 48202.

Summary: This film is a followup of the *ABC of Internal Combustion;* however, it is more detailed concerning the function of the carburetor, piston, piston rings and pins, connecting rods, crankshaft, valve mechanism, ignition, cooling and lubricating systems.

Automobile Fuel System. Chart. Public Relations Staff, General Motors Corp., General Motors Technical Center, Warren, Mich. 48090.

Background for Leadership. 30 min., 16 mm., sd., color. Librarian Technical Service Dept., Dana Parts Co., Box 500, Hagerstown, Ind. 47346.

Summary: Major manufacturing processes in the production of piston rings, chrome plating, sleeve castings, speed control, and valve seals are shown. Attention is given to the research and testing required.

Carburetor Charts. 24″ x 32″. Marvel Schebler Products Division, Borg-Warner Corp., Decatur, Ill. 62521.

Care of a Tractor. 22 min., 16 mm., sd., b&w. Film Library, Roberts Hall, Cornell University, Ithaca, N.Y. 14850.

Summary: This film shows the importance of periodic inspections and the operations necessary for daily, weekly, monthly, semiannual, and seasonal checkup of tractor parts (including the cooling, fuel, and ignition systems). Emphasis is placed on use of the operator's manual. Proper care of tires and adequate lubrication are also stressed.

Case of the Slippery Oil. 40 min., 16 mm., sd., color. Librarian, Technical Service Dept., Dana Parts Co., Box 500, Hagerstown, Ind. 47346.

Summary: The film shows the proper procedure for diagnosing oil consumption and the proper re-ringing of an engine.

Diagnose It First. 80-frame filmstrip, 40 min., color. Librarian, Technical Service Dept., Dana Parts Co., Box 500, Hagerstown, Ind. 47346.

Summary: Six major causes of heavy-duty engine failure and poor performance are analyzed.

Diagnosing Excessive Oil Consumption and Engine Overhaul Procedure. Filmstrip, color. Librarian, Technical Service Dept., Dana Parts Co., Box 500, Hagerstown, Ind. 47346.

Summary: The filmstrip explains the step-by-step procedure used in diagnosing and performing a complete piston-ring job.

Dirt—Engine Enemy No. 1. 10 min., 16 mm., sd., color. Librarian, Technical Service Dept., Dana Parts Co., Box 500, Hagerstown, Ind. 47346.

Summary: This film explains ways of recognizing abrasive wear, ways of preventing abrasives from entering the engine, and procedures to be followed in correcting abrasive wear problems.

Farm Tractor Safety. 18 min., 16 mm., sd., color. Film Library, Roberts Hall, Cornell University, Ithaca, N.Y. 14850.

Summary: This film shows dangers of improper tractor operation. Problems explored in the film include: incorrect hitching, tipping backward, filling gasoline tank, catching clothing, and avoiding highway accidents. The need to teach safe tractor operation is emphasized.

Flames of Progress. 11 min., 16 mm., sd., b&w. Film Library, Roberts Hall, Cornell University, Ithaca, N.Y. 14850.

Summary: This film shows actual combustion in an engine through a transparent quartz head on a specially built, single-cylinder engine.

For Better Tractor Performance. Chart. Public Relations Staff, General Motors Corp., General Motors Technical Center, Warren, Mich. 48090.

Four Stroke Cycle and Flame Travel. Chart. Public Relations Staff, General Motors Corp., General Motors Technical Center, Warren, Mich. 48090.

From Ingot to Engine—The Story of a Piston. Filmstrip, 30 min., color. Librarian, Technical Service Dept., Dana Parts Co., Box 500, Hagerstown, Ind. 47346.

Summary: Each important step in the manufacture and inspection of quality pistons is depicted.

Fuel Cell Powered Tractor. 8 min., 16 mm., sd., color. Allis-Chalmers Manufacturing Co., Dept. 1816, Box 512, Milwaukee, Wis. 53201.

Summary: This film shows the history of fuel cell research; it includes demonstrations which stress the practical application of fuel cell power.

Fuel Cells—Power for the Future. 13 min., 16 mm., sd., color. Allis-Chalmers Manufacturing Co., Dept. 1816, Box 512, Milwaukee, Wis. 53201.

Summary: The film demonstrates how fuel cells are constructed and tested, and it shows achievements in design, with suggested applications for the future.

The Gas Turbine. 15 min., 16 mm., sd., color. Shell Oil Co., 49-07 Northern Boulevard, Flushing, N.Y. 11345.

Summary: The development of the gas turbine engine is traced, its operation is explained, and its use in aircraft is shown. Working models and animated drawings keep the story clear and concise.

Handle With Care. 25 min., 16 mm., sd., color. New Departure Division, General Motors Corp., Bristol, Conn. 06012.

Summary: This film demonstrates the proper way to service ball bearings in the shop and in the field; it includes instruction in the removal, cleaning, lubrication, and re-installation of ball bearings.

Horsesense for Horse Power. 25 min., 16 mm., sd., color. Public Relations Dept., American Oil Co., 910 So. Michigan Ave., Chicago, Ill. 60680.

Summary: This story explains the importance of making correct operating adjustments on the farm tractor and covers correct selection and use of oil for maximum power. The results of adjustment tests are shown on a dynamometer.

Installing Piston Rings in Farm Tractors. Filmstrips, 2 class periods, 35 mm., color. Librarian, Technical Service Dept., Dana Part Co., Box 500, Hagerstown, Ind. 47346.

Summary: This filmstrip gives the step-by-step procedure for diagnosing and performing a complete piston-ring job.

An Introduction to the Heat Engine. 23 min., 16 mm., sd., b&w. Shell Oil Co., 49-07 Northern Boulevard, Flushing, N.Y. 11345.

Summary: The study of conversion of energy in the form of heat into energy in the form of motion is shown, from its beginning in 17th century experiments with steam, to development of the gasoline engine, steam turbine, and diesel engine.

It's Got To Be Good. 10 min., 16mm., sd., b&w. Allis Chalmers Manufacturing Co., Dept. 1816, Box 512, Milwaukee, Wis. 53201.

Summary: The film describes the torture tests to which A.C. equipment is subjected on the proving ground and in the laboratory.

The Miniature Sphere. 24 min., 16 mm., sd. New Departure Division, General Motors Corp., Bristol, Conn. 06012.

Summary: This film depicts most up-to-date techniques of producing ball bearings, illustrating the specialized machines used, the numerous inspections made, and the instrumentation specifically developed for this job.

Oil Films in Action. 16 min., 16 mm., sd., color. Film Library, General Motors Corp., General Motors Building, Detroit, Mich. 48202.

Summary: Transparent plastic, used as a bearing block, enables one to see how oil film pressures vary at different points around the circumference of a journal and how the pressure varies proportionately with the load. The effects of speed and the use of different grades of oil are also shown.

Prescription for Longer Valve Life. Filmstrip, 30 min., color. Librarian, Technical Service Dept., Dana Parts Co., Box 500, Hagerstown, Ind. 47346.

Summary: This filmstrip outlines procedures for diagnosing engine valve problems.

Preventing Oil Loss Through the Valve Guides. 15 min., 23 frames, color. Librarian, Technical Service Dept., Dana Parts Co., Box 500, Hagerstown, Ind. 47346.

Summary: Oil loss through valve guides is discussed.

That High Power Top Inch. Filmstrip, 30 min., color. Librarian, Technical Service Dept., Dana Parts Co., Box 500, Hagerstown, Ind. 47346.

Summary: The filmstrip shows the development of piston rings and how they function in an engine.

Tractor Tragedies. 10 min., 16 mm., sd. Film Library, Roberts Hall, Cornell University, Ithaca, N.Y. 14850.

Summary: Tragedies caused by careless handling of tractors are depicted. The film shows a number of accidents that could have been avoided and explains rules for safe driving.

You're the Doctor. 32 min., 16 mm., sd., b&w. Film Library, Roberts Hall, Cornell University, Ithaca, N.Y. 14850.

Summary: The stories of skilled mechanics in the service departments of farm equipment retailers and how they do their jobs are told.

FARM POWER II (Diesel)

Hours Required

Class, 2; Laboratory, 4

Description

This is a study of the principles of design and construction of different types of diesel engines used on farms and in light industry. Since many aspects of engines have been studied in *Farm Power I*, the emphasis in this course is on types of engine chamber design and injection systems. Theory and principles are studied under actual conditions by running, testing, disassembling, and reassembling components, systems, and engines. Safety is emphasized throughout.

Major Divisions

		Class hours
I.	History of Diesel Development and Fields of Application	2
II.	Comparison of Diesel and Gas Engines	2
III.	Engine Construction, Design, and Types	2
IV.	Fuels and Combustion	2
V.	Engine Power, Rating, and Performance	2
VI.	Combustion Chambers: Thermodynamic Characteristics	4
VII.	Fuel Injection Systems	4
VIII.	Principles and Characteristics of Injectors, Nozzles, and Pumps	8
IX.	Blowers, Superchargers, and Their Application	2
X.	Starting Systems	2
XI.	Governors	2
	Total	32

I. History of Diesel Development and Fields of Application
  1. Diesel definitions
  2. Dr. Rudolf Diesel
  3. Advantages and disadvantages
  4. Carnot, Constant Pressure, and Sabathé Cycle
  5. Development of application

II. Comparison of Diesel and Gas Engines
  1. Original cost
  2. Fuel and operating costs
  3. Operation, maintenance, and repair

III. Engine Construction, Design, and Types
  1. Classification by size, speed, and use
  2. Two- and four-cycle engines
  3. Design features and problems
  4. Scavenging and supercharging
  5. Stationary and moving parts

IV. Fuels and Combustion
  1. Properties of fuel oils
  2. Cetane rating
  3. Combustion and heat values
  4. Ignition lag and diesel knock

V. Engine Power, Rating, and Performance
  1. Power calculations
  2. Power losses
  3. Indicated and brake horsepower efficiency

VI. Combustion Chambers: Thermodynamic Characteristics
  1. Principles of combustion
    a. Turbulence
    b. Oxygen for combustion
    c. Compression ratio
    d. Combustion stages
  2. Types of chambers
    a. Direct injection
    b. Precombustion
    c. Turbulence
    d. Auxiliary

VII. Fuel Injection Systems
  1. Common Rail
  2. Jerk Pumps
  3. Distributor

VIII. Principles and Characteristics of Injectors, Nozzles, and Pumps
  1. Unit injector
  2. Single hole, multiple hole, and pintle nozzles
  3. Spray patterns, size, and dispersion of fuel
  4. American Bosch Pumps
  5. Roosa Master Pumps
  6. Simms Pumps
  7. Scintilla Pumps
  8. C.A.V. Pumps
  9. I.H.C. Pumps
  10. Caterpillar Pumps
  11. Transfer Pumps

IX. Blowers, Superchargers, and Their Application
  1. Port and valve scavenging blowers
  2. Supercharging with rotary or centrifugal blowers
  3. Turbochargers
  4. Engine changes due to supercharging

X. Starting Systems
  1. Compression pressure, temperature, and starting torque
  2. Compressed air
  3. Gasoline engine

    4. Electric starting
    5. Cold weather starting aids

XI. Governors
    1. Speed regulation, speed droop, hunting
    2. Mechanical
    3. Hydraulic
    4. Governor types according to application

Laboratory—64 hours

Laboratory work may be completed concurrently with class discussion of the major divisions, or it may follow. Students are assigned an engine on which to work. Zero defects should be the goal of all repair work. As many of the following topics as time and individual course emphasis permit should be studied:

1. Comparison of diesel systems
2. Starting and running engines
3. Fuel injection nozzles
4. Nozzle testing
5. Unit injectors
6. Unit injector testing
7. Fuel injection pumps
8. Pump calibration
9. Troubleshooting and testing engines
10. Engine service and maintenance

Texts and References

Armstrong *and* Hartman. *The Diesel Engine.*
Audel's Diesel Engine Manual. Theo. Audel & Co.
Barger *and others. Tractors and Their Power Units.*
Fox. *Diesel Operation and Fault Diagnosis.*
Frazee *and* Bedell. *Automotive Fuel and Ignition Systems.*
Judge. *High Speed Diesel Engines.*
Kates. *Diesel and High-Compression Gas Engines.*
Maleev. *Diesel Engine Operation and Maintenance.*
Smith. *The Modern Diesel.*

Visual Aids

The ABC of Internal Combustion. 13 min., 16 mm., sd., color. Film Library, General Motors Corp., General Motors Building, Detroit, Mich. 48202.

The ABC of the Diesel Engine. 18 min., 16 mm., sd., color. Film Library, General Motors Corp., General Motors Building, Detroit, Mich. 48202.

Summary: This film shows how the diesel engine works, how air and fuel are injected into the cylinder, and how the mixture is ignited. This film is to be used as a follow-up of *The ABC of Internal Combustion.*

Detroit Diesel Engine Instruction Charts. Detroit Diesel Engine Division, General Motors Corp., Detroit, Mich. 48228.

The Diesel Story. 19 min., 16 mm., sd., b&w. Shell Oil Co., 49-07 Northern Boulevard, Flushing, N.Y. 11345.

Summary: Development of the diesel is traced from the Otto "silent" gas engine of 1877 to the present.

Engine Tune-Up Procedures Filmstrips. Detroit Diesel Engine Division, General Motors Corp., Detroit, Mich. 48228.

Summary: Each filmstrip and leader's guide covers the complete tune-up procedure, including valve adjustment, injector timing, and governor adjustments, in a step-by-step method for a particular model.

The GM Diesel Engine. Filmstrip. Detroit Diesel Engine Division, General Motors Corp., Detroit, Mich. 48228.

Summary: This filmstrip examines basic engine principles, the operation of the air, fuel, cooling, and lubrication systems, and governor operation as applied to the Series 71 In-Line engine.

The GM Diesel Fuel System. Filmstrip, sd., color. Detroit Diesel Engine Division, General Motors Corp., Detroit, Mich. 48228.

Summary: This is a 2-part filmstrip. Section one explains the operation of the fuel system and factors relating to fuel oil selection. Section two covers operation, preventive maintenance, and trouble-shooting procedures.

Materials, operators' manuals, and service manuals which are available from manufacturers of diesel engines and equipment.

HARVESTING EQUIPMENT

Hours Required

Class, 2; Laboratory, 4

Description

This course is a continuation of the study of farm machines. Emphasis is placed on harvesting equipment: its field operation, adjustment, overhaul, and safety. Field operations provide understanding of the performance of a particular machine as influenced by design, speed, capacity, and adjustment. An important objective is to strengthen the student's judgment, decisionmaking abilities, and techniques for analyzing quality of performance or failures of a particular machine.

Basic principles are developed through discussion, demonstration, and a carefully integrated program of laboratory experiences. The repair program develops skills in the use of testing devices, through an orderly evaluation of mechanical elements of harvesting equipment and problems encountered in its use.

The wide diversification of harvesting machines in different geographical locations places the responsibility for their selection on the local teaching staff. The teaching approach outlined above is applicable to any type of harvesting machine; similar study approaches may be followed for all types of machines. The following major divisions, therefore, are suggested for the study of all harvesting machines; since the grain combine is a relatively universal type of machine, it will be used to illustrate how the major divisions might be adapted.

Major Divisions

	Class hours
I. Machines for Harvesting	4
II. Powering	1
III. Characteristics of Good Field Work	1
IV. Abilities Needed To Become Efficient Operators	1
V. Mechanisms	2
VI. Adjustments	4
VII. Power Train	2
VIII. Flow Patterns	3
IX. Lubrication Systems	2
X. Protective Devices and Safety	1
XI. Testing Devices	3
XII. Special Equipment and Attachments	2
XIII. Hydraulic Systems	2
XIV. Trouble Shooting	2
XV. Economics of Owning Equipment	2
Total	32

I. Machines for Harvesting
  1. Grain combines
    a. History of development
    b. Purpose
    c. Advantages and disadvantages
    d. Wide cylinder or narrow cylinder
    e. Terminology
  2. Other

II. Powering
  1. Power taken from the pulling tractor
  2. Auxiliary engine
  3. Self-propelled unit

III. Characteristics of Good Field Work
  1. The field
  2. The machine
  3. The grain tank

IV. Abilities Needed to Become Efficient Operators
  1. Understanding of the functional design of the combine
  2. Understanding of the basic principles of operation of the combine
  3. Ability to identify combine losses
  4. Knowledge of proper adjustments
  5. Capability of maintaining combine in efficient operating condition
  6. Capability of safe practice and procedures

V. Mechanisms
  1. Cutting
  2. Feeding
  3. Threshing
  4. Separating
  5. Cleaning
  6. Grain collecting

VI. Adjustments
  1. General
  2. According to operator's manual
  3. Interrelationships among adjustments
  4. Conditions (crop, ground, weather)
  5. Speed of travel

VII. Power Train
  1. Source of power
  2. Main drive shaft
  3. Main drive sheave
  4. Distribution of power to cutting area, reel, cylinder, straw walkers, fan, and elevating devices

VIII. Flow Patterns
  1. Cutter bar
  2. Feeder
  3. Elevator to cylinder
  4. Cylinder
  5. Beater
  6. Straw rack
  7. Chaffer
  8. Fan
  9. Re-cleaner
  10. Sieves
  11. Elevators to clean grain storage
  12. Grain tank

IX. Lubrication Systems
  1. General lubricating system
  2. Fittings

3. Sealed bearings
4. Gear cases

X. Protective Devices and Safety
  1. Slip clutches
  2. Shields

XI. Testing Devices
  1. Speed indicators
  2. Thickness gauges
  3. Torque wrench

XII. Special Equipment and Attachments
  1. Straw spreader
  2. Straw windrower
  3. Straw loader
  4. Straw chopper
  5. Corn harvester
  6. Special tracks

XIII. Hydraulic Systems
  1. Driving
  2. Operating cutting head
  3. Lifting reel

XIV. Trouble Shooting
  1. Unthreshed heads
  2. Excessive grain on ground
  3. Too much chaff in grain tank
  4. Checks for correct speeds
  5. Improper cylinder action
  6. Poor cutting action
  7. Improper reel delivery

XV. Economics of Owning Equipment
  1. Overhead Costs
  2. Variable costs
  3. Risk-loss from delayed harvesting
  4. Owning versus custom contracting

Laboratory—64 hours

The function of the laboratory is to provide opportunities for the student to become proficient in the correct operation of harvesting equipment. Approximately the first half of the semester is devoted to field operation of all equipment that is normally used in a particular geographic location. Those adjustments which may be made in the shop prior to actual field operation and subsequent checking of these adjustments in the field are emphasized. Adjustments best accomplished under field conditions are also stressed. It is imperative that each student demonstrate a comprehensive understanding of correct machine operation and the capability of machine adjustment. Since seed, plant, and harvesting losses are important economic factors in farm production, machine adjustment and operating variables are emphasized. The rest of the semester is devoted to shop work on the machines that were used in the field. Having had field experience, the student can best understand why a particular machine part is designed as it is. Safety must be emphasized in all work. Shop activities should include cleaning machines, checking for worn or defective parts, ordering and replacing parts, adjusting machines, and painting them (as needed). These laboratory experiences require familiarity with service manuals, parts catalogs, and testing equipment, as well as the ability to read directions and follow an established pattern in the performance of a given operation. To further develop these skills and understandings, assembly and disassembly of some machines should be provided.

Texts and References

Annual Farm Equipment Red Book. Implement and Tractor Publications Inc.

GIBBONS *and* MOODY. *Power Mechanics.*

Hay Conditioners. Bulletin No. 339. Cornell University.

Hay Conditioners in the Northeastern United States. Bulletin No. 449. Cornell University.

HUNT. *Farm Power and Machinery Management.*

The Self-Propelled Windrower. Bulletin No. 358. Cornell University.

SMITH. *Farm Machinery and Equipment.*

STONE *and* GULVIN. *Machines for Power Farming.*

Operators' and service manuals which are available from various manufacturers.

Visual Aids

Miracles of Paradise Valley. 40 min., 16 mm., sd. Film Laboratory, Cornell University, Roberts Hall, Ithaca, N.Y. 14850.

Summary: This film shows how a community overcame personal and property damage caused by farm accidents.

HYDRAULICS I (Basic)

Hours Required

Class, 2; Laboratory, 2

Description

This is an introduction to the principles and the various common designs and systems in hydraulics. Application of hydraulics to both farm and light industrial equipment is emphasized. It includes a study of the technical language of fluid power, including graphical symbols, industrial standards, and available components. Design, application, operation, adjustment, and maintenance of hydraulic units are studied.

Major Divisions

	Clas hours
I. Introduction: History and Development	2
II. Fluid Power Principles	6
III. Elements of Hydraulic Systems	2
IV. Hydraulic Symbols, Diagrams, Schematics	4
V. Hydraulic Fluids	1
VI. Fluid Power Pumps	4
VII. Fluid Power Valves	4
VIII. Fluid Power Cylinders	2
IX. Hydraulic Seals, Packings, Lines, and Fittings	1
X. Hydraulic Systems	4
XI. Hydraulic Accessories	1
XII. Hydraulic Maintenance	1
Total	32

I. Introduction: History and Development
  1. Scope and course procedures
  2. History of hydraulic developments
  3. Advantages and applications of fluid power

II. Fluid Power Principles
  1. Fundamentals
    a. Force, pressure, area
    b. Work, power, horsepower, torque
    c. Basic lever principle
  2. Pascal's law
    a. Application
    b. Multiplication of forces
    c. Fluid properties
  3. Boyle's law
  4. Bernoulli's theorem
  5. Charles' law, Darcy's formula, Reynolds' number, Torricelli's theorem
  6. Hydrostatics and hydrodynamics

III. Elements of Hydraulic Systems
  1. Components
  2. Basic circuits
  3. Design factors

IV. Hydraulic Symbols, Diagrams, Schematics
  1. JIC and ASA symbols
  2. Application of symbols to components
  3. Reading and interpretation of diagrams and schematics

V. Hydraulic Fluids
  1. Types and classification
  2. Chemical and physical characteristics
  3. Additives
  4. Fluid maintenance and service requirements

VI. Fluid Power Pumps
  1. Types of pumps
  2. Design, application, and servicing
    a. Reciprocating
    b. External and internal gear
    c. Gear-like
    d. Screw
    e. Vane
    f. Axial and radial piston
    g. Generated-rotor
    h. Centrifugal

VII. Fluid Power Valves
  1. Directional control
    a. Rotary
    b. Open center spool
    c. Closed center spool
    d. Flow divider
  2. Pressure control
    a. Safety
    b. Relief
    c. Counterbalance, sequence, unloading
    d. Pressure reducing
  3. Flow control
    a. Needle
    b. Globe
    c. Gate
    d. Check
    e. Relief

VIII. Fluid Power Cylinders
  1. Single acting
  2. Double acting
  3. Cushioning
  4. Telescoping
  5. Stroke control
  6. Application and lever principle

IX. Hydraulic Seals, Packings, Lines, and Fittings
  1. Classification
  2. O-rings
  3. "U," chevron, and "V" packing

    4. Cup, flange, mechanical, and metallic seals
    5. Compression gaskets and packing
    6. Piping, tubing, flexible hose, and fittings

X. Hydraulic Systems
    1. Basic circuit
    2. Open center
    3. Tandem open center
    4. Closed center
    5. Blocked return line
    6. Through flow

XI. Hydraulic Accessories
    1. Accumulators
    2. Gauges
    3. Heat exchangers

XII. Hydraulic Maintenance
    1. Filtering fluid
    2. Straining fluid
    3. Flushing a hydraulic system
    4. Servicing and maintenance time schedules

Laboratory—32 hours

Laboratory projects may be completed concurrently with class discussion of the major divisions or they may follow it. Familiarity with the hardware, components, circuits, and systems of oil hydraulics, in relation to the basic principles of fluid mechanics, should be stressed. Zero defects should be the goal of all repair work. Laboratory exercises should include as many of the following areas as time and individual course emphasis allow:

1. Hydraulic power applications
2. Basic principle demonstrations
3. Components, circuits, and system design
4. Schematics of systems (using symbols)
5. Disassembly, assembly, and testing of pumps
6. Disassembly, assembly, and testing of valves
7. Disassembly, assembly, and testing of cylinders
8. Construction of circuits
9. Operation of equipment

Texts and References

Aeroquip Basic Hydraulics Program. Bulletin No. 632. Aeroquip Corp.

ASA Graphical Symbols and Diagrams. American Standards Association.

Basic Hydraulics. Racine Hydraulics and Machinery Co.

Design, Operation, and Maintenance of Hydraulic Equipment for Use with Fire Resistant Fluids. National Fluid Power Association.

Dimension Identification Code for Fluid Power Cylinders. National Fluid Power Association.

Fluid Motors. American Society of Mechanical Engineers.

Fluid Power Handbook and Directory. Industrial Publishing Corp.

Fluids and Seals. The Dynex Co.

Glossary of Terms for Fluid Power. National Fluid Power Association.

GRAHAM. *Audel's Pumps, Hydraulics, Air Compressors.*

HENKE. *Closing the Loop.*

Hydraulic Machinery. Texaco, Inc.

Hydraulic Power Transmission. Standard Oil Co.

Hydraulic Theory. J. I. Case Co.

Hydraulics. International Harvester Co.

Industrial Hydraulics Manual. Vickers, Inc.

JIC Hydraulic Standards. Industrial Publishing Corp.

LEWIS. *Design of Hydraulic Control Systems.*

MACKIN. *Hydraulic Controls on Machine Tools.*

MCNEIL. *Trouble Free Hydraulics.*

MCNICKLE. *Simplified Hydraulics.*

PIPPENGER *and* HICKS. *Industrial Hydraulics.*

PIPPENGER *and* KOFF. *Fluid Power Controls.*

STREETER. *Handbook of Fluid Mechanics.*

Oil company hydraulic booklets published by major oil companies and manufacturers' service and operators' manuals.

Visual Aids

Application of Pascal's Law, Part I. 15 min., 16 mm., sd., color. Government Films Dept., United World Films, 1445 Park Ave., New York, N.Y. 10016.

Summary: This film shows the function of input and output pistons and the way work is done and measured.

Application of Pascal's Law, Part II. 15 min., 16 mm., sd. color. Government Films Dept., United World Films, 1445 Park Ave., New York, N.Y. 10016.

Summary: The film continues the demonstration in the above mentioned film. It shows how forces can be multiplied by using more than one piston, and it illustrates the application of this principle to hydraulic brakes and jacks.

Basic Hydraulics. 15 min., 16 mm., sd., color. Government Films Dept., United World Films, 1445 Park Ave., New York, N.Y. 10016.

Summary: This film depicts the development of a basic hydraulic circuit by adding components, as required, to make a complete working circuit.

Controlled Power. 20 min., 16 mm., sd., color. Vickers, Inc., A & E Center, Box 302, Troy, Mich. 48084.

Summary: This film shows the use of fluids as a power transmitting medium. Applications cover many varieties of hydraulic equipment: machine tools, earthmoving equipment, farm machinery as well as marine, aircraft, and missiles.

Derivations of Pascal's Law, Part I. 15 min., 16 mm., sd., color. Government Films Dept., United World Films, 1445 Park Ave., New York. N.Y. 10016.

Summary: This film compares weights of equal volumes of oil and water; defines density, pressure, and force; and briefly shows application of Pascal's law to Navy gun turrets.

Derivations of Pascal's Law, Part II. 15 min., 16 mm., sd., color. Government Films Dept., United World Films, 1445 Park Ave., New York, N.Y. 10016.

Summary: This film demonstrates that confined fluids transfer force equally to all parts of the container. It defines Pascal's law.

Harnessing Liquids. 12 min., 16 mm., sd., b&w. Shell Oil Co., 49-07 Northern Blvd., Flushing, N.Y. 11345.

Summary: The film explains hydraulic principles through demonstration with a bottle of liquid. It shows how small forces can be multiplied in such applications as brakes, aircraft landing gear, service station hoists, and metal forming presses.

Hydraulic Oils. 28 min., sd., color. Texaco, Inc., 135 E. 42nd Street, New York, N.Y. 10017.

Summary: This film shows properties and qualities of mineral-base fluids for hydraulic power transmission. By tests and behavior in various applications, it demonstrates the need for proper selection.

HYDRAULICS II (Equipment Applications)

Hours Required

Class, 2; Laboratory, 4

Description

This course is a study of the application of hydraulic principles to farm and light industrial equipment. Inspection, testing, and servicing of hydraulic circuits, systems, and components such as power steering, power brakes, and hydraulic transmissions are studied. Appropriate testing procedures and equipment are utilized. System difficulties and common service problems are also diagnosed. Opportunity is provided for the field operation of light industrial equipment.

Major Divisions

Major Divisions	*Class hours*
I. Introduction	1
II. Testing Equipment and Test Procedures	3
III. Tractor Hydraulic Lift Systems	3
IV. Power Steering Systems	3
V. Power Brakes	2
VI. Hydraulic Transmissions	3
VII. Fluid Motors	3
VIII. Variable Speed Drives	2
IX. Accumulators, Servo Valves, and Electrical Components	4
X. Light Industrial Equipment	8
Total	32

I. Introduction
   1. Review of basic hydraulic principles
   2. Application of basic hydraulic principles to farm and light industrial equipment

II. Testing Equipment and Test Procedures
   1. Types of test equipment
   2. Component and circuit testing procedures

III. Tractor Hydraulic Lift Systems
   1. Components, design, and operating principles
   2. Depth and position control, weight transfer principle
   3. Adjustment and servicing

IV. Power Steering Systems
   1. Power assist systems
   2. Full hydraulic systems
   3. Adjustment and servicing

V. Power Brakes
   1. Types
   2. Principles of operation
   3. Adjustment and servicing

VI. Hydraulic Transmissions
   1. Hydrostatic
   2. Hydrodynamic
   3. Hydraulic couplings
   4. Torque converters
   5. Power shift
   6. Parking brake
   7. Interlocks
   8. Adjustment and servicing

VII. Fluid Motors
   1. Gear
   2. Vane
   3. Axial or radial piston
   4. Applications to equipment
   5. Adjustment and servicing

VIII. Variable Speed Drives
   1. Types
   2. Principles of operation and applications
   3. Adjustment and servicing

IX. Accumulators, Servo Valves, and Electrical Components
  1. Introduction to servo control
  2. Types of accumulators and servo valves
  3. Principles of operation and applications
  4. Electrical components and their applications

X. Light Industrial Equipment
  1. Opportunities for employment
  2. Markets and applications
  3. Types of equipment
  4. Matching type of equipment to the job
  5. Equipment operation
  6. Adjustment and servicing

Laboratory—64 hours

Laboratory time should be spent on equipment and jobs similar to those encountered in the field. Zero defects should be the goal of all repair work. Component, circuit, system analysis and testing are studied from a performance viewpoint. Laboratory projects should include as many of the following areas as time and individual course emphasis allow:

1. Operating light industrial equipment
2. Lift systems
3. Power steering systems
4. Power brakes
5. Hydraulic transmissions
6. Fluid motors
7. Variable speed drives
8. Accumulators, servo and electrical components
9. Test procedures and testing equipment
10. Equipment type, job application, and actual operation

Texts, References, Visual Aids

See listing for *Hydraulics I (Basic)*.

PLANTING AND TILLAGE EQUIPMENT

Hours Required

Class, 2; Laboratory, 6

Description

This course is designed to acquaint the student with principles and conditions in the field operation of planting and tillage machinery. It includes the study and checking of machine construction principles, operational speeds, rated loads, and power loss. Emphasis is placed upon principles and methods of testing, calibration, and adjustment of the machines before and during field operation. Repairs are made, and safety procedures are developed.

Major Divisions

	Class hours
I. Introduction to Farm Machines	3
II. Primary Tillage Equipment	9
III. Secondary Tillage Equipment	6
IV. Planting Equipment	7
V. Weed-Control Equipment	5
VI. Lawn Mowing Equipment	2
Total	32

I. Introduction to Farm Machines
  1. The relation of farm machines to agriculture
    a. Farm machines as industrial units (principles of design and operation)
    b. Changes in types of machines (function and operating conditions)
    c. Machines and types of farming (capacities and economic efficiency)
  2. Materials of construction
    a. Nonmetallic
    b. Nonferrous metals
    c. Ferrous metals
    d. Bearings
    e. Springs
    f. Bolts
  3. Mechanical power transmission
    a. Belts
    b. Chains
    c. Gears
    d. Protective devices
  4. Hydraulic lifts
    a. Cylinders
    b. Control units
  5. Lubrication
    a. Purposes
    b. Types
    c. Methods of application

II. Primary Tillage Equipment
  1. Plows
    a. Moldboard
    b. Disk
    c. Rotary

- d. Chisel and subsurface
- 2. Garden tillage equipment
  - a. Small plows
    - (1) Sizes and types
    - (2) Adjustment
  - b. Rotary tillers
    - (1) Sizes and types
    - (2) Adjustment
- 3. Selection
  - a. Type of soil
  - b. Number of acres
  - c. Machine performance
    - (1) Capacities
    - (2) Field patterns
    - (3) Quality performance
    - (4) Performance testing
  - d. Power performance
    - (1) Power
    - (2) Power measurement
    - (3) Tractor tests
    - (4) Drawbar performance
    - (5) Traction efficiency
  - e. Machinery costs
    - (1) Fixed
    - (2) Variable
- 4. Field use
  - a. Adjustment
  - b. Speeds
- 5. Maintenance
  - a. Cleaning and checking
  - b. Repairing
  - c. Storing

III. Secondary Tillage Equipment
- 1. Harrows
  - a. Disk
  - b. Spike-tooth
  - c. Spring-tooth
  - d. Special
- 2. Other seedbed preparation tools
  - a. Land rollers and pulverizers
  - b. Subsurface tillage tools and field cultivators
  - c. Rotary hoes
- 3. Selection
  - a. Type of soil
  - b. Number of acres
  - c. Machine performance
  - d. Power performance
  - e. Machinery costs
- 4. Field use
  - a. Adjustment
  - b. Speeds
- 5. Maintenance
  - a. Cleaning and checking
  - b. Repairing
  - c. Storing

IV. Planting Equipment
- 1. Row crop planters
  - a. Corn
  - b. Cotton
  - c. Sorghum, pea, and peanut
  - d. Beet and bean
  - e. Potato
  - f. Transplanting or plant-setting machines
  - g. Vegetable planters and other precision planters
- 2. Broadcast and drill planters
  - a. Grain drills
  - b. Multiple-use drills
  - c. Grass-sprig planter
- 3. Selection
  - a. Type of seed
  - b. Number of acres
  - c. Machine performance
  - d. Power performance
  - e. Machinery costs
- 4. Field use
  - a. Adjustment or setting
  - b. Speeds
- 5. Maintenance
  - a. Cleaning and checking
  - b. Repairing
  - c. Storing

V. Weed-Control Equipment
- 1. Flame
- 2. Chemical
  - a. Sprayers
    - (1) Hydraulic
    - (2) Hydro-pneumatic
    - (3) Blower
    - (4) Airplane
  - b. Dusters
    - (1) Orchard
    - (2) Electronic
    - (3) Airplane
- 3. Cultivators
- 4. Selection of equipment
  - a. Kind of crop
  - b. Number of acres
  - c. Machine selection and economic performance

d. Power performance
e. Machinery costs
VI. Lawn Mowing Equipment
1. Rotary mowers
a. Types and sizes
b. Blade sharpening and balancing
c. Safety
2. Reel mowers
a. Types and sizes
b. Blade sharpening and adjusting
c. Safety

Laboratory—96 hours

During the first half of the semester, the laboratory is conducted in the field. This will provide the student experience in the safe operation of the various field machines and afford him the opportunity to make final adjustments under field conditions after preliminary adjustments have been made in the shop. In the second half of the semester, the student cleans machines, orders parts, and makes actual machine repairs. New machines are set up and given a predelivery service check.

As many of the following topics and activities should be considered and performed as time and individual course emphasis allow:

A. In the field
1. Instruction in tractor driving and safe operation
2. Use of the trailer plow to develop plow principles
3. Use of the mounted plow and its proper adjustment
4. Power requirements and slippage tests with plows
5. Plow design and plowing results
6. Different types of secondary tillage equipment and what can be accomplished with them
7. Row crop planters
8. Broadcast-type planters
9. Weed-control sprayers and dusters
10 Lawn mowers
B. In the shop
1. Cleaning and preparing equipment for storage and lubrication
2. Checking for worn, broken, or bent parts and ordering new parts
3. Replacement of parts on plows
4. Replacement of parts on row crop planters
5. Overhaul and calibration of grain drills
6. Reconditioning of secondary tillage equipment
7. Painting of equipment
8. Special problems: hydraulic lifts and controls, power transmissions, and lubrication

Texts and References

BAINER *and others. Principles of Farm Machinery.*
GIBBONS *and* MOODY. *Power Mechanics.*
HUNT. *Farm Power and Machinery Management.*
Moldboard Plows. Bulletin 2172. U.S. Department of Agriculture.
SMITH. *Farm Machinery and Equipment.*
STONE *and* GULVIN. *Machines for Power Farming.*
What You Should Know About Farm Tires. B.F. Goodrich Co. Operators' and service manuals which are available from the various manufacturers.

POWER UNIT TESTING AND DIAGNOSIS

Hours Required

Class, 2; Laboratory, 4

Description

This course in power unit testing and diagnosis is based on the principles studied in the electricity, farm power, and physics courses. The electrical and mechanical systems and components of tractors and power units are studied. Simple testing devices as well as the most recent electrical testing and diagnostic equipment available are used. Malfunctions and their interrelationship with components and systems are also studied. Particular emphasis is placed on the use of a logical sequence of steps in testing and diagnosing malfunctions and on the adjustment, repair, and tuneup of power units.

Major Divisions

	Class hours
I. Principles of Power Unit Testing and Diagnosis	8
II. Testing and Diagnosing Component/System Troubles	20
III. Operating the Tuneup Shop	4
Total	32

- I. Principles of Power Unit Testing and Diagnosis
  - 1. Introduction
  - 2. Review of operational principles of gas and diesel engines
  - 3. Ignition system principles
    - a. Distributor
    - b. Magneto
    - c. Alternator
    - d. Transistor
    - e. Other
  - 4. Types of testing equipment available
  - 5. Systematic approach to testing and diagnosis
- II. Testing and Diagnosing Component/System Troubles
  - 1. Dynamometer
  - 2. The charging circuit
    - a. Storage battery
    - b. Generator
    - c. Alternator
    - d. Voltage regulator
  - 3. The ignition system
    - a. Coil
    - b. Condenser
    - c. Distributor
    - d. Spark plugs
    - e. Wiring harness
    - f. Electronic ignition
    - g. Magneto
    - h. Timing
  - 4. Oscilloscope testing and diagnosis
  - 5. Starting circuit
    - a. Starting motor
    - b. Cranking motor drives
    - c. Starting motor controls
  - 6. Fuel system
  - 7. Valves and compression
  - 8. Cooling system testing
  - 9. Auxiliary electrical circuits
  - 10. Lubrication system
- III. Operating the Tuneup Shop
  - 1. Tuneup procedure
  - 2. Testing equipment needed
  - 3. Shop operating procedures
    - a. Relationship to other departments
    - b. Charging for service
  - 4. Farm calls
  - 5. Record keeping

Laboratory—64 hours

The laboratory time should be utilized by the student to test the components that have been studied. Several makes and types of testing equipment should be available, and the student should become familiar with all equipment in the laboratory. Several laboratory periods near the end of the course should be devoted to diagnosing tractor and power unit malfunctions. The machines used for this purpose may include those "bugged" by the instructor or those obtained by the student from dealers or farms for testing and tuneup.

Texts and References

AC Spark Plug, Oscilloscope and Tune-Up Manual. AC Spark Plug Division, General Motors Corp.

An Introduction to the Automotive Electrical System. DR-9010. Delco-Remy Division, General Motors Corp.

BARGER *and others. Tractors and Their Power Units.*

Better Ignition. DR-5141. Delco-Remy Division, General Motors Corp.

CROUSE. *Automotive Mechanics.*

Delco-Remy Maintenance Handbooks. DR-324—1, 2, 3, 4. Delco-Remy Division, General Motors Corp.

Delco-Remy Test Specifications. DR-324S, S-1, S-2. Delco-Remy Division, General Motors Corp.

Farm Tractors. Engineering Bulletin FT-53. American Oil Corp.

FRAZEE *and* BEDELL. *Automotive Electrical Systems.*

———. *Automotive Fuel and Ignition Systems.*

Heavy Duty Generator Regulators. DR-5170, DR-5190. Delco-Remy Division, General Motors Corp.

Introducing the Delcotron Generator ana the Charging Circuit. DR-9011. Delco-Remy Division, General Motors Corp.

It's Easy To Be an Expert . . . Battery Man, That Is. DR-9010. Delco-Remy Division, General Motors Corp.

JONES. *Farm Gas Engines and Tractors.*

Periodic Maintenance and Circuit Checks. DR-5221. Delco-Remy Division, General Motors Corp.

Regulation and the Charging Circuit. DR-9015. Delco-Remy Division, General Motors Corp.

Service and Installation Manual. Champion Spark Plug Co.

Service Tips. DR-9019. Delco-Remy Division, General Motors Corp.

Spark Plug Service Manual and Tune-Up Procedures. AC Spark Plug Division, General Motors Corp.

The Cranking Circuit. DR-9025. Delco-Remy Division, General Motors Corp.

The How and Why of Automotive Tune-Up Service. Check-Chart Corp.

The How and Why of Tire, Battery and Accessory Service. Check-Chart Corp.

Tune-Up Manual. Automotive Electric Association.

Tune-Up Manual. Ignition Manufacturers Institute.

VENK *and* BILLIET. *Automotive Engines Maintenance and Repair.*

WETZEL. *Automotive Diagnosis and Tune-Up.*

Visual Aids

The ABC of Internal Combustion. 13 min., 16 mm., sd., color. Public Relations Staff, General Motors Corp., Film Library. General Motors Building, Detroit, Mich. 48202.

Summary: The four-stroke cycle is clearly illustrated along with the fundamentals of valve operation, carburetion, and ignition timing.

Better Ignition. Filmstrip, 22 min., sd. Technical Literature Dept., Delco-Remy Division, Anderson, Ind. 46011.

Summary: This filmstrip contains detailed information on distributors, ignition coils and condensers, ignition theory, and the maintenance of Delco-Remy ignition equipment.

The Cranking Circuit. Filmstrip, 12 min., sd., color. Technical Literature Dept., Delco-Remy Division, Anderson, Ind. 46011.

Summary: This filmstrip shows in nontechnical terms the units in the cranking circuit and how they operate together.

Delco-Remy Training Charts and Manuals. 12 sections, 26" x 36", over 150 charts. Technical Literature Dept., Delco-Remy Division, Anderson, Ind. 46011.

Flames of Progress. 11 min., 16 mm., sd., b&w. Film Library, Roberts Hall, Cornell University, Ithaca, N.Y. 14850.

Summary: Using a transparent quartz head on a specially built single-cylinder engine, the film shows actual combustion in an engine.

Fuel Cell Powered Tractor. 8 min.. 16 mm., sd., color. Allis Chalmers Manufacturing Co., Dept. 1816, Box 512, Milwaukee, Wis. 53201.

Summary: This film contains a history of fuel cell research. It includes demonstrations which stress the practical application of fuel cell power.

Fuel Cells—Power for the Future. 13 min., 16 mm., sd., color. Allis Chalmers Manufacturing Co., Dept. 1816, Box 512, Milwaukee, Wis. 53201.

Summary: This film demonstrates fuel cell construction and testing, achievements in design, and suggested future applications.

Heavy Duty Generator Regulators. Filmstrip, 2 parts, 22 min. each, sd. Technical Literature Dept., Delco-Remy Division, Anderson, Ind. 46011.

Summary: This filmstrip covers the operation and maintenance of Delco-Remy generator-regulators.

Regulation and the Charging Circuit. 12 min., filmstrip, sd., color. Technical Literature Dept., Delco-Remy Division, Anderson, Ind. 46011.

Summary: This filmstrip covers the theory of operation of the generator, regulator, and battery, which comprise the charging circuit.

Tractor Wall Chart. DR–5050, electrical systems, 42" x 54". Technical Literature Dept., Delco-Remy Division, Anderson, Ind. 46011.

20,000 Volts Under the Hood. Filmstrip, 22 min., sd. Technical Literature Dept., Delco-Remy Division, Anderson, Ind. 46011.

Summary: The filmstrip explains the basic operation of the electrical units in the ignition circuit.

PRINCIPLES OF FARM MECHANIZATION

Hours Required

Class, 3; Laboratory, 6

Description

This course is designed to afford students the opportunity to plan and develop farm building layouts. Consideration is given to desirable arrangements of the equipment within the buildings and to the efficient flow of materials. Local farms and school farms may be used for practical application of the principles and methods learned. Functional arrangement of units in farm mechanization systems is studied, and safety elements are emphasized throughout the course.

Major Divisions

		Class hours
I.	Materials Handling Systems	3
II.	Flow Pattern Development	4
III.	Requisites for an Efficient System	4
IV.	Feed Handling Equipment	9
V.	Correlation of Harvesting Equipment With Materials Handling Systems	3
VI.	Storing	3
VII.	Processing	6
VIII.	Feeding	12
IX.	Waste Disposal	4
	Total	48

I. Materials Handling Systems
  1. Purposes of system
    a. Speeds operations
    b. Saves labor
    c. Makes work easier
  2. Exploration for the development of a system
    a. Types of materials to be handled

    b. Amount of materials to be handled
    c. Kinds of equipment
        (1) Transporting
        (2) Storing
        (3) Processing
        (4) Feeding
        (5) Disposing of waste
3. Planning the system
    a. Providing for maximum efficiency
    b. Using natural processes; i.e., gravity
    c. Employing mechanization

II. Flow Pattern Development
1. Determine the steps in handling and utilizing a representative material
    a. Identification of start of handling process
    b. Transporting
    c. Storing
    d. Feeding
    e. Disposing of waste
2. Diagram flow patterns

III. Requisites for an Efficient System
1. Short distances for movement
    a. Proper building layout
    b. Correct relation of feeding areas to buildings
2. Ability to handle large amounts
3. Provisions for continuous movement

IV. Feed Handling Equipment
1. Type of equipment
    a. Trucks
    b. Wagons
    c. Pneumatic equipment
    d. Auger or other devices for unloading
2. Capacity of equipment
    a. Sizes
    b. Motor horsepower
3. Performance as affected by design of equipment
4. Selection of equipment

V. Correlation of Harvesting Equipment With Materials Handling Systems
1. Type of equipment
    a. Combines
    b. Balers
    c. Choppers and/or waferers
    d. Potato diggers
    e. Fruit pickers
    f. Egg handling devices
    g. Other
2. Capacity of equipment
    a. Bushels per hour
    b. Tons per hour
    c. Acres per hour
3. Functional design features of the equipment

VI. Storing
1. Kinds of material
2. Purpose
    a. For market
    b. For farm use
3. Type of facility
4. Size or capacity
5. Selection of equipment

VII. Processing
1. Form to be used
    a. Ground
    b. Chopped
    c. Pelleted
    d. Wafered
    e. Packaged
2. Equipment needed
    a. Type
    b. Capacity
    c. Specialization
3. Transporting from processing equipment
    a. To storage
    b. To market
    c. To feeder
4. Selection of equipment

VIII. Feeding
1. Requirements of animals
    a. Kind
        (1) Beef
        (2) Dairy
        (3) Swine
        (4) Poultry
    b. Number
    c. Size
2. Planning of the facilities and equipment
    a. Straight bunk
    b. Circular bunk
    c. Auger
    d. Chain
    e. Elevators
    f. Self-unloading
3. Selection of equipment

IX. Waste Disposal
1. Quantities to be handled
    a. Capacity of equipment
    b. Size and number of animals

2. Planning the system
    a. Type of product
    b. Daily handling
    c. Storage for extended periods
3. Selection of equipment

Laboratory—96 Hours

In the laboratory, the student familiarizes himself with various principles applicable to systems of handling materials on the farm. He studies equipment used in these systems, and has the opportunity to participate in the installation of at least one major piece of equipment.

As many opportunities as possible should be provided for planning and measuring layouts, designing specific parts of a system, and integrating them into the overall system. Dimensional working sketches are important aspects of the study and should be developed and applied wherever possible.

Work with the operable mechanical devices comprising a system is provided in order that load carrying and speed characteristics can be accurately appraised. Special emphasis is placed on speed, designed capacities, safety, and quality of construction.

Principles studied in the electricity course are integrated with farm mechanization principles, in order to develop a better appreciation of the many electrical controls used on the machines and the wiring problems encountered with them.

The laboratories should parallel class discussion as closely as possible. Examples of laboratory experiences which might be developed are:

1. Surveying farms for operational flow patterns
2. Developing plans for farm layouts which provide adequate flow patterns for as many farm products as possible
3. Studying the various makes and types of equipment employed in feed handling—their design, capacities, operation, installation, functional considerations, safety, and adjustment. The following specific phases should be considered:
    a. Harvesting
    b. Storing
    c. Processing
    d. Feeding
    e. Disposing of waste
4. Installing a major piece of equipment

Texts and References

Clayton *and others. Farmstead Engineering for Dairy Farms.*

Davis *and* Furry. *Bulk Bins for Dairy Feed.* Bulletin No. 350. *Farmstead Modernization—Key to Increased Profits.* Behlen Manufacturing Co.

Guest. *Feed Ration Processing for Dairy, Poultry and Other Livestock.*

———. *Mechanical Equipment for Handling and Feeding Forage.* Bulletin No. 348.

Guest *and* Spencer. *Milking Machine System.* Bulletin No. 64.

Hall. *Processing Equipment for Agricultural Products.*

Henderson. *Planning Water Systems for Farm and Home. Home and Farm Water Supply Manual.* F. E. Myers & Bros. Co.

Hull. *Farm Feed Processing with Portable Grinder Mixers.*

Hundtoft *and* Guest. *Handling Hay Crops.* Series of four Bulletins—Nos. 363, 364, 365, 366.

Perry. *Mow Hay Driers.* Bulletin 1008.

Puckett. *Automatic Feeding Equipment for Livestock and Poultry.* Bulletin No. 2198.

Rehkugler *and* Millier. *Performance of Auger Conveyors for Handling Grain and Ground Feeds.* Bulletin No. 325.

Stanton. *Pipeline Milking—Its Place on Your Farm.* Bulletin No. 1024.

Stewart. *Handling Farm Materials.* Bulletin 198.

U.S. Department of Agriculture. *Drying Ear Corn by Mechanical Ventilation.* Bulletin No. MP–919.

———. *Equipment for Cooling Milk on the Farm.* Bulletin No. 2175.

———. *Mechanical Silo Unloaders for Upright Silos.* Bulletin No. 2188.

———. *Planning the Electric Water System and Plumbing for Your Farmstead.* Bulletin No. MP–674.

Wright. *Rural Water Supply and Sanitation.*

TRANSMISSIONS AND FINAL DRIVES

Hours Required

Class, 2; Laboratory, 4

Description

This course is a study of power transmission and mechanical driving systems. It follows the gas engines course and deals primarily with the components, systems, operation, and control of wheel and crawler tractors. Engine and hydraulic systems are excluded. Understanding and application of the fundamentals and principles of mechanical systems of power transmission are stressed. Special emphasis is placed on transmissions and final drives.

Major Divisions

	Class hours
I. Gears and Bearings	3
II. Friction Clutches	2
III. Transmissions	10
IV. Differentials	2
V. Final Drives	3
VI. PTO, Belts, and Pulleys	3
VII. Steering	2
VIII. Brakes	2
IX. Wheels, Tires, and Tracks	3
X. Tractor Stability and Traction Devices	2
Total	32

I. Gears and Bearings
  1. Gear types and application
  2. Gear ratios
  3. Bearing types and application
  4. Service and maintenance
II. Friction Clutches
  1. General design and characteristics
  2. Application and control of various designs
  3. Clutch adjustment and repair
III. Transmissions
  1. Relationship between power, speed, and torque
  2. Types
    a. Single shift
    b. Dual shift
    c. Shift-on-the-go
      (1) Power director
      (2) Case-O-Matic
      (3) Synchro range
      (4) Select-O-Speed
      (5) Torque amplifier
      (6) Multi-power
      (7) Ampli-torq
      (8) Power booster drive
      (9) Hydra-power
  3. Maintenance and service
    a. Lubrication
    b. Inspection
    c. Repair
IV. Differentials
  1. Function and components of differentials
  2. Principles of operation
  3. Differential locks and their application
  4. Inspection and service
V. Final Drives
  1. Function and types
  2. Components
  3. Maintenance and service
VI. PTO, Belts, and Pulleys
  1. ASAE speed and dimensional standards
  2. Controls and power trains for PTO operation
  3. Pulleys and belts
    a. Size
    b. Speed
    c. Materials
  4. Controls and power train for belt-pulley operation
  5. Service and maintenance
VII. Steering
  1. Types and components on wheel tractors
  2. Types and components on crawler tractors
  3. Adjustment and service
VIII. Brakes
  1. Types
  2. Principles of operation
  3. Components
  4. Adjustment and service
IX. Wheels, Tires, and Tracks
  1. Wheel types
  2. Tires
    a. Size
    b. Tread design
    c. Loading
    d. Care
  3. Tracks
    a. Types
    b. Undercarriage
    c. Checks for wear
    d. Servicing and repair
X. Tractor Stability and Traction Devices
  1. Weight, traction, and rolling resistance relationships
  2. Distribution of weight and pressure
    a. Applied to soil
    b. Effect of drawbar pull and height of hitch point

   c. Influence of mounted implements, vertical loads, and terrain on stability
3. Nebraska Test interpretation and application

Laboratory—64 hours

The major portion of the laboratory periods should be used for studying different kinds of power transmissions and driving systems. Disassembly, identification of parts and the placement and function of the components, determining gear ratios, repair procedures, and reassembly should be included. The same basic procedures should be followed for clutches, differentials, final drives, PTO, brakes, and mechanical steering. At least one or two laboratory periods should be used for field operation of tractors, to study traction and tractor stability. Zero defects should be the goal of all repair work. A maximum of two students should be assigned to each tractor or unit. Safety must be emphasized in all aspects of the course.

Texts and References

Annual Farm Equipment Red Book. Implement and Tractor Publications, Inc.

ASAE Yearbook. American Society of Agricultural Engineers.

Ball and Roller Bearings. International Harvester Co.

Barger *and others. Tractors and Their Power Units.*

Basic Ball Bearing Types. New Departure Division, General Motors Corp.

Bearing Failure Identification. New Departure Division, General Motors Corp.

Crouse. *Automotive Mechanics.*

Delco Moraine Brake Service Manual. Delco Moraine Division, General Motors Corp.

Delco Moraine Power Brake Service Manual. Delco Moraine Division, General Motors Corp.

Frazee *and others. Automotive Brakes and Power Transmission Systems.*

Greenwood. *Mechanical Power Transmission.*

Jones. *Farm Gas Engines and Tractors.*

New Departure Ball Bearings for Farm Implements. New Departure Division, General Motors Corp.

Power Goes to Work. General Motors Corp.

Promsberger and Bishop. *Modern Farm Power.*

Seals, Separators, Lubricants. New Departure Division, General Motors Corp.

Service Manuals for Various Heavy Duty Automatic Transmission. Allison Division, General Motors Corp.

Service Procedure for Ball Bearings. New Departure Division, General Motors Corp.

Shop Manual for Timken Roller Bearings. Timken Roller Bearing Co.

Smith. *Farm Machinery and Equipment.*

Stone and Gulvin. *Machines for Power Farming.*

Transmission Theory. J. I. Case Co.

What You Should Know About Farm Tires. B. F. Goodrich Co. Manufacturer's service manuals which are available through branches or distributorships.

Visual Aids

Brake System. 22" x 34" wall chart. Public Relations Staff, General Motors Corp., General Motors Technical Center, Warren, Mich. 48090.

Handle With Care. 25 min., 16 mm., sd., color. New Departure Division, General Motors Corp., Bristol, Conn. 06012.

Summary: This film demonstrates the proper way to service ball bearings in the shop and out in the field. It includes removal, cleaning, lubricating, and reinstalling procedures.

Rear Axle Assembly. 22" x 34" chart. Public Relations Staff, General Motors Corp., General Motors Technical Center, Warren, Mich. 48090.

Three Speed Gear Transmission. 22" x 34" chart. Public Relations Staff, General Motors Corp., General Motors Technical Center, Warren, Mich. 48090.

The Torque Converter Story. 22 min., 16 mm., sd., color. Allis-Chalmers Manufacturing Co., Dept. 1816, Milwaukee, Wis. 53201.

Summary: The film shows, in detail, the principle of the hydraulic torque converter and how it is used in transmitting power from engine to final drive in crawler tractors.

Typical Gear Combinations. 22" x 34" chart. Public Relations Staff, General Motors Corp., General Motors Technical Center, Warren, Mich. 48090.

WELDING I (Elementary)

Hours Required

Class, 0; Laboratory, 4

Description

This course is designed to acquaint the student with the equipment and processes used in welding and cutting mild steel and cast iron. The following topics are included: Various types of welding and cutting equipment, welding of mild steel in various positions, cutting of mild steel with oxy-acetylene torch and arc, hard surfacing, brazing, and welding of cast iron. Since the emphasis is on the development of skills and understanding in welding, laboratory time alone is scheduled;

all discussions and demonstrations are conducted in the laboratory.

Laboratory—64 Hours

Various types of welds are made on pieces of mild steel that are ¼"x2"x3". Each weld should be tested by using a hydraulic bend tester or by clamping in a vise and breaking it with a sledge hammer. Each student must master each type of weld before being allowed to move on to the next position.

Safety is of paramount importance in a welding course and must be emphasized continuously. The student should be required to wear gloves and safety goggles at all times in the laboratory.

Each of the following exercises should be demonstrated by the instructor and practiced by the student:

1. Introduction to welding equipment
2. Striking an arc and running a bead
3. Selecting electrodes for mild steel
4. Welding mild steel
   a. Flat butt position
   b. Flat position
   c. Horizontal fillet position
   d. Vertical butt position
   e. Vertical fillet position
   f. Overhead butt position
   g. Overhead fillet position
5. Cutting mild steel and cast iron with an oxy-acetylene torch and electric arc
6. Brazing
7. Controlling distortion in welding
8. Identifying metals
9. Welding cast iron
10. Hard surfacing

Texts and References

GIACHINO *and others. Welding Skills and Practices.*
GRIFFEN *and* RODEN. *Basic Arc Welding.*
JEFFERSON. *Welding Encyclopedia.*
KUGLER. *Arc Welding Lessons for School and Farm Shop.*
PARKER. *Farm Welding.*
The Oxy-Acetylene Handbook. Union Carbide Corporation
Welding Handbook. Section II. American Welding Society.

Visual Aids

Braze Welding. 13 min., 16 mm., sd., color. Linde Division, Union Carbide Corp., 300 First Ave., Needham Heights, Boston, Mass. 02194.

Summary: This film shows the step-by-step technique for joining steel sheet and plate by braze welding.

Flame Cutting. 11 min., 16 mm., sd., color. Linde Division, Union Carbide Corp., 300 First Ave., Needham Heights, Boston, Mass. 02194.

Summary: This film illustrates the basic techniques for cutting metals with the oxy-acetylene torch. It shows how to make straight line and bevel cuts, how to cut circles and simple shapes, and how to pierce holes in heavy plate.

Hard Surfacing. 10 min., 16 mm., sd., color. Linde Division, Union Carbide Corp., 300 First Ave., Needham Heights, Boston, Mass. 02194.

Summary: This film demonstrates the techniques of applying hard-facing alloys to metal parts by oxy-acetylene welding in order to protect them from abrasion, impact, erosion, heat, and chemical corrosion. Correct heating, metal flow, and removal of impurities are shown for plates and thin-edged metal parts.

Prevention and Control of Distortion in Arc Welding. 20 min., 16 mm., sd., color. Association Films, Ridgefield, N.J. 07657.

Summary: The film explains the reasons why distortion takes place during welding and gives details of many means of preventing and controlling this distortion.

A film directory is available from the American Welding Society, 345 East 47th Street, New York, N.Y. 10017.

WELDING II (Advanced)

Hours Required

Class, 1; Laboratory, 4

Description

A study of welding based on the mechanical, physical, and chemical properties of metals commonly used in agricultural and light industrial equipment. The processes used in the manufacture of metal parts are studied. Advanced welding techniques used to weld metals which are difficult to weld and which are used in agricultural and light industrial equipment are studied and practiced. Part of the course introduces some of the fundamentals of the design of welded structures, with emphases on determining loads and stresses, selecting suitable materials, and learning the principles of functional design.

Major Divisions

	Class hours
I. Metal Manufacturing Processes	2
II. Mechanical Properties of Metals	2

	Class hours
III. Physical and Chemical Properties of Metals	2
IV. Mechanical, Physical, and Chemical Properties of Metals Commonly Used in Agricultural and Light Industrial Equipment	6
V. Basic Principles for Design of Welded Structures	4
Total	16

I. Metal Manufacturing Processes
  1. Manufacture of steel
  2. Heat treating
II. Mechanical Properties of Metals
  1. Tensile strength
  2. Yield point
  3. Elastic limit
  4. Stress
  5. Strain
  6. Ductility
  7. Elasticity
  8. Strength
    a. Compressive
    b. Fatigue
    c. Impact
III. Physical and Chemical Properties of Metals
  1. Toughness
  2. Hardness
    a. Brinell Hardness
    b. Rockwell Hardness
  3. Corrosion resistance
  4. Electrical resistance
  5. Fusibility
  6. Thermal conductivity
  7. Thermal expansion
IV. Mechanical, Physical, and Chemical Properties of Metals Commonly Used in Agricultural and Light Industrial Equipment
  1. Low carbon steels
  2. Medium carbon steels
  3. High carbon steels
  4. Alloy steels
  5. Gray cast iron
  6. White cast iron
  7. Malleable iron
  8. Ductile iron
  9. Wrought iron
  10. Cast steels
  11. Stainless steels
  12. Brass
  13. Bronze
  14. Aluminum
V. Basic Principles for Design of Welded Structures
  1. Development of basic design
  2. Calculating loads and stresses
    a. Tension
    b. Compression
    c. Shear
    d. Twisting and bending
  3. Selection of materials to be used
    a. Type of material
    b. Size and shape
  4. Completion of the design
    a. Design of joints
    b. Stiffening and bracing

Laboratory—64 hours

The laboratory work emphasizes development of skills in welding and the practical application of welding to agricultural and light industrial equipment. Metals which are difficult to weld, such as high carbon steel, alloy steels, stainless steel, and aluminum used in agricultural and light industrial equipment, are studied and welded. Methods of testing welds, such as the guided bend test, tensile strength test, and magna flux test, are studied. Each student designs and constructs a welding project and devotes some time to repairing broken parts by welding. Suggested design and construction projects include: utility trailer, engine stand, jack stand, A-frame for hoist, machinery trailer, post hole digger, hay elevator, and a tractor snow plow.

Texts and References

BLODGETT. *Design of Weldments.*

JEFFERSON. *Welding Encyclopedia.*

JEFFERSON and WOODS. *Metals and How To Weld Them.*

Procedure Handbook of Arc Welding Design and Practice. The Lincoln Electric Co.

Texts and references used in Basic Welding also may be used in this course.

Visual Aids

Design for Arc Welded Structures. 15 min., 16 mm., sd., color. Association Films, Ridgefield, N.J. 07657.

Summary: This film shows the fundamentals of welded design and its advantages in planning, tonnage savings, fabrication, and erection.

Designing Machinery for Arc Welding. 15 min., 16 mm., sd., color. Association Films, Ridgefield, N.J. 07657.

Summary: This film shows how arc welding permits a new freedom in design of machinery. The fundamentals of welded design are reviewed and new ideas presented.

This Is Steel. 33 min., 16 mm., sd., color. Modern Talking Picture Service, 3 East 54th Street, New York, N.Y. 10022.

Summary: This film is an account of steelmaking which includes the following: the mining of raw materials; the iron-producing furnace; the steel-producing processes, including open-hearth and electric-furnace; rolling mills; and the production of wire, pipe, tool steel, and forgings.

A film directory is available from the American Welding Society, 345 East 47th Street, New York, N.Y. 10017.

Mathematics and Science Courses

APPLIED MATHEMATICS

Hours Required

Class, 4; Laboratory, 0

Description

This course is designed to familiarize the student with common types of mathematical problems that he will encounter in agricultural equipment technology and to develop his confidence in solving such problems. The first part of the course includes a review of arithmetic, fundamental business calculations, and determination of the areas and volumes of simple figures and objects. The remainder of the course is devoted to learning the use of the slide rule and solving agricultural equipment problems. Typical problems include determination of mechanical advantage, horsepower, torque, and Ohm's Law.

Major Divisions

	Class hours
I. Whole Numbers	2
II. Common Fractions	2
III. Decimals	2
IV. Measurement	4
V. Percentage and Average	2
VI. Finance	4
VII. Graphs and Statistics	4
VIII. Symbols	8
IX. Equations	8
X. Ratio and Proportion	2
XI. Squares, Square Roots, and Exponents	4
XII. The Slide Rule	4
XIII. Formulas	4
XIV. Geometric Lines and Shapes	8
XV. Trigonometry Functions	6
Total	64

I. Whole Numbers
  1. Addition of whole numbers
  2. Subtraction of whole numbers
  3. Multiplication of whole numbers
  4. Division of whole numbers

II. Common Fractions
  1. Concept of common fractions
  2. Addition of fractions
  3. Subtraction of fractions
  4. Multiplication of fractions
  5. Division of fractions
  6. Scale reading

III. Decimals
  1. Concept of decimals
  2. Addition of decimals
  3. Subtraction of decimals
  4. Division of decimals
  5. Multiplication of decimals
  6. Fractional equivalents
  7. Reading outside and inside micrometers

IV. Measurement
  1. Standardized units of measure
  2. Principles of linear measurement
  3. Principles of angular and circular measure
  4. Principles of surface measure
  5. Principles of volume measure

V. Percentage and Average
  1. Concept of percent and percentages
  2. Application of percentage (base and rate)
  3. Averages and estimates
  4. Fractional equivalents
  5. Simple percentage problems
    a. Grades (inclines)
    b. Discounts
    c. Profit and loss, commissions
    d. Interest and taxes
    e. Percentage error and averages

VI. Finance
  1. Money and time calculations
  2. Manufacturing cost and discounts
  3. Payrolls and taxes

VII. Graphs and statistics
  1. Development and interpretation of bar graphs
  2. Development and interpretation of line graphs
  3. Development and interpretation of circle graphs

VIII. Symbols
  1. Concept of symbols
  2. Application of symbols
     a. Addition
     b. Subtraction
     c. Multiplication
     d. Division

IX. Equations
  1. A concept of equations
  2. Positive and negative quantities
  3. Solving equations
     a. Addition
     b. Subtraction
     c. Multiplication
     d. Division
     e. Practical problems involving equations

X. Ratio and Proportion
  1. The concept of ratio
  2. Ratio problems
  3. The concept of proportion
  4. Proportion problems

XI. Squares, Square Roots, and Exponents
  1. Square of whole numbers
  2. Square root of whole numbers
  3. Square of fractions and algebraic numbers
  4. Square root of fractions and algebraic numbers
  5. Square root tables
  6. Powers other than square

XII. The Slide Rule
  1. Operation of the slide rule
     a. Multiplication
     b. Division
     c. Square root and cube root
  2. Solving agricultural equipment problems using the slide rule

XIII. Formulas
  1. The concept and use of formulas
  2. Application of formulas to squares, rectangles, and regular solids
  3. Application of formulas to circles and parts of circles
  4. Application of special formulas
     a. Circular measurement
     b. Ohm's Law
     c. Temperature
     d. Horsepower
     e. Cylindrical volume

XIV. Geometric Lines and Shapes
  1. Concepts of basic geometric forms
     a. Lines
     b. Angles
     c. Circles
  2. Basic flat shapes
  3. Basic solid shapes
  4. Congruent and symmetrical flat and solid shapes

XV. Trigonometry Functions
  1. Concept of trigonometry function
  2. Solving agricultural equipment problems with trigonometry
     a. Inclines
     b. Force diagrams
     c. Height of objects

Texts and References

FENSKE *and others. Arithmetic in Agriculture.*
OLIVO. *Basic Mathematics Simplified.* Volumes I and II.
Practical Problems in Mathematics, Automotive Trades Delmar Publishers, Inc.
ROSENBERG. *Business Mathematics.*
SNYDER. *Essential Business Mathematics.*

APPLIED PHYSICS I
(Mechanics and Heat)

Hours Required

Class, 2; Laboratory, 4

Description

This course is designed to provide the student with an understanding of the basic principles of physics relating to mechanics and heat, and the ways in which these principles are directly utilized in agricultural equipment technology. This understanding will provide a foundation for other courses in the curriculum.

The topics and the order in which they are presented should be integrated with the technical courses in the curriculum. Thus, the properties of fluids and gases are presented early in the course in order that the principles learned can be applied in the Hydraulics I and Farm Power I courses.

Each topic must be introduced in such a manner that its application to agricultural equipment is apparent. The basic laws of physics are studied after introduction of some problem in agricultural equipment with which the student is familiar. Introduction of the basic laws is followed by examples of their application to farm and light industrial machinery. The solution of mathematical problems is necessary if the student is to apply what he has learned in this course to other courses in the curriculum.

Major Divisions

	Class hours
I. Basic Measurement	2
II. Properties of Solids, Liquids, and Gases	6
III. Motion and Momentum	6
IV. Work, Energy, and Power	8
V. Statics	4
VI. Heat	6
Total	32

I. Basic Measurement
  1. Science and measurement
     a. Units of measurement
     b. Systems of measurement: metric and English
     c. Review of mathematics
  2. Methods of measurement
     a. United States standards; tolerances
     b. Use of measuring devices in agricultural equipment technology: vernier caliper, micrometer, optical comparator, balances, spring scales

II. Properties of Solids, Liquids, and Gases
  1. Structure of matter
     a. Atoms
     b. Elements, compounds, mixtures
  2. Elasticity and rigidity of a body
     a. Torsion: modulus of elasticity
     b. Deformation: stress, strain, fatigue
  3. Properties of fluids
     a. Density, specific gravity
     b. Pascal's Law: hydraulics
     c. Archimedes' Principle: buoyancy
     d. Viscosity: application to lubricants
     e. Capillarity
     f. Surface tension
     g. Pressure, flow, head
  4. Properties of gases
     a. Volume
     b. Temperature
     c. Pressure: atmospheric pressure, application to pumps and carburetors

III. Motion and Momentum
  1. Speed and velocity
  2. Acceleration
  3. Newton's Laws of motion
  4. Law of gravitation: free fall
  5. Inertia
  6. Circular motion: centrifugal force
  7. Friction: coefficient of friction

IV. Work, Energy, and Power
  1. Forces
     a. Direction
     b. Amount
     c. Units of force
  2. Energy
  3. Power
     a. Definition
     b. Units of power
  4. Simple machines including: inclined plane, pulleys, wheel and axle, belts, gears, chains
     a. Aspects of work, energy, and power
     b. Mechanical advantage
     c. Friction in machines
     d. Efficiency
     e. Power transmission by gears, chains, belts, and shafts

V. Statics
  1. Vector forces
     a. Definition of a vector
     b. Resolution of vectors: graphical, trigonometrical
  2. Equilibrium
     a. Definition
     b. Center of gravity: its relation to tractor tipping
     c. Suspended bodies
     d. Braces and guy wires
  3. Principles of moments
     a. Definition
     b. Torque
     c. Levers
     d. Application of principles of moments to structures, cranes, loaders, and trusses
     e. Alignment and weight shift problems encountered with various tractor hitches

VI. Heat
  1. Definition of heat: effects on molecular motion

2. Temperature
    a. Definition
    b. Temperature scales: boiling and freezing points
    c. Temperature-indicating devices
    d. Specific heat
3. Thermal expansion of solids, liquids, and gases
4. Heat transfer
    a. Conduction
    b. Convection
    c. Radiation
5. Heat engines
6. Refrigeration principles

Laboratory—64 hours

Laboratory experiments may be completed concurrently with classroom study of the major divisions of the course or they may follow it. As many of the following laboratory experiences should be provided as time allows:

1. Use of measuring devices
2. Calculations of the density of solids and liquids
3. Elastic properties of materials
4. Measurements of buoyancy of liquids
5. Friction and coefficient of friction
6. Determining the center of gravity of a series of forces and the reaction at supports of a series of parallel forces
7. Demonstrating weight shift and effects on alignment using various tractor hitches.
8. Calculation of forces on the members of a structure
9. Application of Newton's Second Law to forces in cables and hoists
10. Characteristics of motion of a projectile compared to a freefalling object
11. Measuring the momentum of a body
12. Centrifugal and centripetal force
13. Conservation of energy in simple machines
14. Conversion of a system of concurrent forces into a vector diagram
15. Analyzing a system of forces
16. Coefficient of linear expansion of various materials
17. Specific heat
18. Measuring the heats of fusion and vaporization of a substance

Texts and References

BEISER. *Modern Technical Physics.*
BENUMOF. *Concepts in Physics.*
JOSEPH *and others. Physics for Engineering Technology.*
MCCORMICK. *Fundamentals of College Physics.*
MILLER. *College Physics.*
SAUNDERS *and* KIRKPATRICK. *College Physics.*
SEMAT. *Fundamentals of Physics.*
SMITH *and* COOPER. *Elements of Physics.*
VERWIEBE *and others. Physics—A Basic Science.*
WHITE. *Descriptive College Physics.*

APPLIED PHYSICS II (Electricity)

Hours Required

Class, 2; Laboratory, 4

Description

This course introduces the basic principles of electricity and the ways in which electricity is used in agriculture. The various types of electric motors and controls and their application to mechanized farm equipment and systems are studied.

Major Divisions

		Class hours
I.	Basic Principles of Electricity	4
II.	Production and Uses of Electricity	4
III.	Electric Circuits	4
IV.	Electric Motors for Agricultural Use	4
V.	Motor Controls	6
VI.	Grounding	4
VII.	Planning a Farm Wiring Layout	6
	Total	32

I. Basic Principles of Electricity
  1. Electron theory
  2. Ohm's Law
      a. Series circuits
      b. Parallel circuits
      c. Combination circuits
  3. Magnetism
  4. Electro-magnetic induction
      a. Transformers
      b. Generators
      c. Motors
      d. Lenz Law

II. Production and Uses of Electricity
  1. Chemical
  2. Magnetic

3. Heat
4. Light
5. Safety
    a. Hazards involved
    b. Underwriters Laboratory
    c. Introduction to National Electrical Code
    d. Local codes
    e. Inspection

III. Electric Circuits
1. General circuits
    a. Wire size
    b. Different wiring methods
        (1) Conduit
        (2) Armored cable
        (3) Nonmetallic sheathed cable
        (4) U.F. cable
    c. Overcurrent protection
        (1) Fuse, fusitron, fusestat, and minibreaker
        (2) Circuit breaker
    d. Outlet and switch boxes
        (1) Purpose
        (2) Types
        (3) Size
        (4) Supporting boxes
        (5) Securing cable and conduit to boxes
    e. Making wire connections and joints
        (1) Removing insulation
        (2) Terminals
        (3) Solderless connectors
2. Motor circuits
    a. Conductors
    b. Branch circuit protective device
    c. Motor disconnect
    d. Motor controller
    e. Motor running overcurrent protection

IV. Electric Motors for Agricultural Use
1. Advantages and disadvantages of electric motors as a source of power for agriculture
2. Principles of operation
    a. Split phase
    b. Capacitor start—induction run
    c. Capacitor start—capacitor run
    d. Repulsion start—induction run
    e. Universal
3. Selecting electric motors
    a. Type
    b. Size
    c. Enclosure
    d. Bearings
    e. Mounting devices
4. Motor installation
    a. Reversing direction of rotation
    b. Changing connections for dual voltage motor
5. Motor care and maintenance

V. Motor Controls
1. Types of controls
    a. Manually operated
        (1) Safety switch
        (2) Manual motor starter
    b. Automatically operated
        (1) Time clock
        (2) Pressure switch
        (3) Limit switch
        (4) Time-delay relay
2. Magnetic starter
    a. Principle of operation
    b. Application to farm motors

VI. Grounding
1. Purpose of grounding
2. Grounded wire—polarizing
3. Grounding wire—equipment ground

VII. Planning a Farm Wiring Layout
1. Meter location
2. Feeder size
3. Service entrance equipment
4. Branch circuits

Laboratory—64 hours

The laboratory time in this course is used to perform experiments which will help the student learn and demonstrate the physical principles of electricity, and develop skills in using electricity on the farm. Some of these exercises, such as wiring general circuits and motor controls, will require more than one laboratory period. Laboratory exercises can be selected from the following activities:

1. Demonstrate permanent and electromagnetism
2. Demonstrate electromagnetic induction applied in transformers, simple generators, and motors
3. Relate Ohm's Law to power factor
4. Study AC and DC circuits
5. Study and construct lighting circuits
6. Diagram the wiring of electric motors
7. Study and demonstrate motor circuits
8. Study and use motor controls

9. Study magnetic motor starters
10. Study generators
11. Plan and diagram a farmstead wiring layout
12. Make a field trip to an electrified farm
13. Make a field trip to power-company generating or distribution plant

Texts and References

Electrical Terms. American Association for Agricultural Engineering and Vocational Agriculture.

Farm Electric Motors—Selection, Protection and Drives. American Association for Agricultural Engineering and Vocational Agriculture.

Farm Electric Sales Handbook. Edison Electric Institute.

Farm Electrification. Edison Electric Institute.

Farmstead Wiring Handbook. Edison Electric Institute.

HAMILTON. *Using Electricity on the Farm*.

KITTS and NABBEN. *Farm Electricity*.

LYTEL. *ABC's of Electric Motors and Generators*.

Maintaining the Farm Wiring and Lighting System. American Association for Agricultural Engineering and Vocational Agriculture.

National Electric Code. National Board of Fire Underwriters.

RICHTER. *Practical Electrical Wiring*.

STEINBERG and FORD. *Elecricity and Electronics*.

Suggestions for Teaching Electric Motors for the Farm. Edison Electric Institute.

Visual Aids

Electrical Power and Common Sense. 28 min., 16 mm., sd., color. New York State Electric and Gas Corp., 62 Henry St., Binghamton, N.Y. 13905.

Summary: In this film are suggested practical hints for safe practices in the use of electricity.

Farm Better Electrically. 28 min., 16 mm., sd., color. Niagara Mohawk, 300 Erie Blvd. West, Syracuse, N.Y. 13202.

Summary: This film illustrates the many ways in which electric power helps the farmer in operating his business. Predictions are made for future use of electricity on the farm.

ACCOUNTING FOR AGRICULTURAL EQUIPMENT BUSINESS

Hours Required

Class, 3; Laboratory, 0

Description

This course is an introduction to double-entry accounting for the agricultural equipment business. The student should learn the language of accounting theory and practice which will increase his ability to communicate in the business world. The necessity of accurate accounting data in making important business decisions should be emphasized. An accounting course should help the student develop accuracy and efficiency as he applies basic accounting principles to the agricultural equipment industry.

Methods of presenting basic principles of accounting and other factual information should generally follow the lecture-discussion and demonstration techniques. Problems taken from agricultural equipment businesses should be checked and discussed to whatever extent seems desirable, the extent of the discussion depending upon the difficulty of the work involved. Other teaching methods and devices which create interest and hold attention should be used; for example, illustrations in textbooks on blackboard, and with overhead projectors.

Major Divisions

	Class hours
I. Fundamental Accounting Relationships	2
II. Accounting Statements	6
III. The General Ledger	3
IV. The General Journal and Posting	3
V. Special Journals	9
VI. Subsidiary Ledgers	2
VII. Notes and Interest	2
VIII. Systems and Controls	2
IX. Plant Assets and Depreciation	4
X. Completion of the Accounting Cycle	8
XI. Payroll Accounting	7
Total	48

I. Fundamental Accounting Relationships
  1. Need for accounting
  2. Principles and practices
  3. Definition of accounting
  4. Basic business operations
  5. Assets, liabilities, and owner's equity
  6. Transactions and their effect on the accounting equation
  7. Accounting statements

II. Accounting Statements
  1. Accounting period
  2. Balance sheet
    a. Account form
    b. Report form
    c. The classified statement
  3. Income statement
    a. Service-type business
    b. Merchandising-type business
    c. Combined service- and merchandising-type business
    d. The classified income statement
  4. Capital statement (when not a part of the income statement)
  5. Interrelationship of accounting statements

III. The General Ledger
  1. Recording transactions in accounts
  2. Accounts
    a. Standard form
    b. Balance form
  3. Rules for debit and credit and determining balances
    a. Asset, liability, and owner's equity accounts
    b. Income and expense accounts
  4. Chart of accounts
  5. Nature and use of the trial balance

IV. The General Journal and Posting
  1. Need for journals
  2. Two-column journal
  3. Recording entries in the general journal
    a. Routine entries
    b. Adjusting entries
    c. Closing entries
  4. Relationships between the journal, ledger, and posting

V. Special Journals
  1. The cash-receipts journal
    a. Single- and multi-column journals

    - b. Cash discounts
    - c. Sources of cash receipts
    - d. Journalizing and posting cash receipts
    - e. Controlling accounts and the subsidiary ledger
    - f. Advantages of using special journals
  - 2. The cash disbursements journal
    - a. Single- and multi-column journals
    - b. Journalizing and posting cash payments
    - c. Special recording problems
    - d. Controlling accounts and the subsidiary ledger
  - 3. The sales journal
    - a. Recording transactions and posting
    - b. Sales returns and allowances
    - c. Sales taxes
    - d. Credit terms
    - e. Control accounts and subsidiary ledger
  - 4. The purchases journal
    - a. Purchasing procedures
    - b. Recording transactions and posting
    - c. Purchases returns and allowances
    - d. Control accounts and subsidiary ledger
  - 5. The combined journal
    - a. Constructing a combined journal
    - b. Recording transactions and posting
    - c. Advantages and limitations
- VI. Subsidiary Ledgers
  - 1. The accounts receivable ledger
    - a. Recording and posting procedures
    - b. Checking against the control
  - 2. The accounts payable ledger
    - a. Recording and posting procedures
    - b. Checking against the control
- VII. Notes and Interest
  - 1. Use of credit instruments in business
  - 2. Determining interest and due dates
  - 3. Recording note transactions
- VIII. Systems and controls
  - 1. Accounting systems
  - 2. Internal control over cash
  - 3. Use of bank account, bank statement, and bank reconciliation
  - 4. Petty cash and other special funds
- IX. Plant Assets and Depreciation
  - 1. Nature of plant assets and depreciation
  - 2. Depreciation methods
  - 3. Recording depreciation and reporting on financial statements
  - 4. Disposal of plant assets
- X. Completion of the Accounting Cycle
  - 1. Outline of the periodic summary for a service or trading business
  - 2. Trial balance, adjustments, and work sheet
  - 3. Merchandise inventory and adjustments
  - 4. Preparation of financial statements and schedules
  - 5. Recording and posting adjusting entries
  - 6. Recording and posting closing entries
  - 7. Ruling the ledger
  - 8. Post-closing trial balance
- XI. Payroll Accounting
  - 1. Determining and recording of gross pay, deductions, and net pay
  - 2. Other compensation methods
  - 3. Paying the payroll
  - 4. Individual earnings records
  - 5. F.I.C.A. and withholding taxes
    - a. Employee statements
    - b. Employer records and statements
  - 6. Unemployment taxes—State and Federal
  - 7. Workmen's Compensation Insurance

Texts and References

CARSON *and others. College Accounting.*

Instructional Manual for FER 500A Bookkeeping System (FER 501). National Retail Farm Equipment Association.

MEIGS *and* JOHNSON. *Accounting.*

NISWONGER *and* FESS. *Accounting Principles.*

VANVOORHIS *and others. College Accounting: Theory and Practice, Part I.*

———. *Problems and Working Papers for College Accounting, Part I.*

AGRICULTURAL EQUIPMENT TECHNOLOGY SEMINAR I

Hours Required

Class, 1; Laboratory, 0

Description

This is a course designed to orient the beginning student to the entire agricultural equipment technology program and to the agricultural equipment industry. A brief introduction to the new type of learning situation he faces is followed by an explanation of the objectives of the seminar and the ways in which they will be accomplished. Consideration is also given to job opportunities and practices in the field and to problems typically encountered by those working in it.

Student panel reports and class discussion on pertinent topics are included in this course. Students should be assigned to panel groups at the first or second meeting of the class; it is necessary, however, that they have assistance and instructional guidance so they will choose topics which are within the scope of the course.

Student responsibility for preparing reports and for leading class discussions on their chosen topics should be emphasized. Panel reports should be written and documented prior to oral presentation. A notebook consisting of complete class notes of the student's contribution to his assigned panel report should be required. Student panels can be expanded to include guest speakers from the industry, and field trips may be made to mechanized farms or other places of special interest in order to acquaint students with the industry. The class should be encouraged to question panel members, especially if controversial topics are under discussion.

Major Divisions

	Class hours
I. The Student and the School	2
II. The Library and Its Use	1
III. Opportunities in the Agricultural Equipment Field	5
IV. The Meaning of Work	1
V. Human Relations Problems	3
VI. Public Relations	2
VII. Communications within the Agricultural Equipment Business	2
Total	16

I. The Student and the School
   1. Physical facilities, regulations, academic requirements
   2. Planning use of time
      a. Study
      b. Student activities
   3. Seminar objectives and plan of operation
   4. Courses in agricultural equipment technology and their interrelationships
   5. Assignment of topics and schedule for panel reports

II. The Library and Its Use
   1. Why technicians need a library
   2. Library organization and facilities
   3. Services of the library staff
   4. How to use the library

III. Opportunities in the Agricultural Equipment Field
   1. Types of job opportunities
      a. Dealerships
      b. Manufacturers
      c. Farmers and farming
      d. Credit institutions
      e. Other
   2. Training required
      a. Necessity for training
      b. Types of training
         (1) Formal courses
         (2) On-the-job
         (3) Internship programs
         (4) Manufacturer-sponsored service and sales schools
         (5) Baccalaureate and graduate programs
   3. Placement
      a. Determining qualifications for various jobs
      b. Nature of placement changes (promotion, demotion, transfer, discharge)
      c. Performance evaluation

IV. The Meaning of Work
   1. "A day's labor for a day's pay" philosophy
   2. Various concepts of labor
      a. Commodity
      b. Machinery
      c. Good will
      d. Individual differences
      e. Citizenship
      f. Customer attitude
      g. Partnership
      h. Eclectic approach

V. Human Relations Problems
   1. Employee-employee relationships
      a. Seniority
      b. Business etiquette and ethics
   2. Employee-customer relationships
      a. Appearance
      b. "Everyone in the business is a salesman" concept
      c. Policies and procedures for sales and services

VI. Public Relations
   1. Importance of good public relations
   2. Business image
   3. Public relations procedures
      a. Business practices
      b. Employee-community relationships

VII. Communications Within the Agricultural Equipment Business
   1. Communications in the agricultural equipment business defined
   2. Kinds of communications in the agricultural equipment business
      a. Employer to employee
      b. Employee to employee
      c. Employee to employer
   3. Barriers to communication
   4. Continual promotion of effective communication

Texts and References

Aurner. *Effective Communication in Business.*
Calhoon. *Managing Personnel.*
Chruden *and* Sherman. *Personnel Management.*
Davis. *Human Relations at Work.*
Davis *and* Scott. *Readings in Human Relations.*
Dealer's Management Manual. (Available from major equipment companies.)
Flippo. *Principles of Personnel Management.*
French. *The Personnel Management Process: Human Resources Administration.*
Gardner *and* Moore. *Human Relations in Industry.*
Heckmann *and* Huneryager. *Human Relations in Management.*
Human Relations in Agricultural Occupations. Ohio State University.
Implement and Tractor Flat Rate Manuals. Implement and Tractor Publications, Inc.
Implement and Tractor Service Manuals. Implement and Tractor Publications, Inc.
Service Center Management Manual. International Harvester Co.
Jucius. *Personnel Management.*
Keily *and* Walters. *How To Find and Apply for a Job.*
McGregor. *The Human Side of Enterprise.*
Odiorne. *Personnel Policy: Issues and Practices.*
Operators Manuals. (Available from manufacturers)
Parts Manuals. (Available from manufacturers)
Personnel Management, Policies and Practices. (Loose-leaf reference book for use in the library only)
Pfiffner. *The Supervision of Personnel; Human Relations in the Management of Men.*
Scott *and others. Personnel Management: Principles, Practices, and Point of View.*
Shop Service Manuals. (Available from manufacturers' service departments)
Small Business Administration. *Human Factors in Small Business.*
———. *Personnel Management.*
Spates. *Human Values Where People Work.*
Strauss *and* Sayles. *Personnel: The Human Problems of Management.*
Wiksell. *Do They Understand You? A Guide to Effective Oral Communication.*
Wilson. *Living With Yourself.*
———. *Understanding People.*
Wilson. *Farm and Power Equipment Retailers Handbook.*

Reference Periodicals

The following periodicals may be used to keep up to date on current trends, issues, and problems (See periodical list in Bibliography for addresses):

Administrative Management.
Agricultural Engineering.
Business Management.
Farm Journal.
Farm Power Equipment.
Hoard's Dairyman.
Implement and Tractor.
Journal of Farm Economics.
The Office.
Personnel.
Personnel Administration.
Personnel Journal.
Successful Farming.
Supervisory Management.

Visual Aids

The films listed can be rented from educational film libraries unless otherwise indicated. If a rental source is not convenient, send requests to the appropriate firms and they will refer them to a film library.

Developing Cooperation. 14 min., 16 mm., sd., b&w. Norwood Films, 926 New Jersey Avenue, NW., Washington, D.C. 20001.

Summary: This film stresses the importance of workers' cooperation on any job. Examples from industry are used to illustrate good and poor methods of developing cooperation.

The Dynamics of Leadership Series. Audio Visual Center, Indiana University, Bloomington, Ind. 47405.

The Anatomy of a Group. 30 min., 16 mm., sd., b&w.
Summary: This film defines the group as a collection of individuals with a common purpose, a participation pattern, a communication system, a well developed social climate, mutually adopted standards, an organizational structure, and prescribed procedures to be followed in their relations.

Diagnosing Group Operations. 30 min., 16 mm., sd., b&w.
Summary: This film attempts to determine whether a discussion group is operating effectively in diagnosing problems; it suggests possible solutions to the problems presented.

Individual Motivation and Behavior. 30 min., 16 mm., sd., b&w.

Summary: This film illustrates how behavior of each group member is affected by physical needs, psychological needs, and forces outside the group which act upon him.

Sharing the Leadership. 30 min., 16 mm., sd., b&w.

Summary: In this film, leadership is defined as a set of group functions; a good leader is defined as one who helps the group accomplish its goals.

Getting Along With Others. 29 min., 16 mm., sd., b&w. Business Education Films, 5113 16th Avenue, Brooklyn, N.Y. 11204.

Summary: This film emphasizes interest in others, acceptance, and understanding as factors in getting along with people.

The Grievance. 30 min., 16 mm., sd., b&w. McGraw-Hill Text-Film Division, 330 West 42d Street, New York, N.Y. 10036.

Summary: This film presents a hypothetical case to show methods by which legitimate employee grievances can be settled.

Person to Person Communications. 14 min., 16 mm., sd., color or b&w. Roundtable Productions, 275 S. Beverly Drive, Beverly Hills, Calif. 90213.

Summary: This film emphasizes the importance of listening in determining unspoken factors which affect communications—assumptions, viewpoints, feelings.

Personnel Management Series. McGraw-Hill Text-Film Division, 330 West 42nd Street, New York, N.Y. 10036.

Communications. 13 min., 16 mm., sd., b&w.

Summary: This film shows ways of promoting adequate communication between employees and employers. It illustrates the value of effective communications and points out that communications should be a two-way process.

The Employment Interview. 11 min., 16 mm., sd., b&w.

Summary: This film concerns the employment interview in the selection and placement of personnel.

Grievance Hearing. 16 min., 16 mm., sd., b&w.

Summary: This film is a dramatization of a case settlement by a grievance committee in a factory; it stresses compromise between the contending parties.

Job Evaluation and Merit Rating. 13 min., 16 mm., sd., b&w.

Summary: This film describes the work of the job analyst. It emphasizes the value of accurate analysis of the work required for different job levels and the objective rating of individual performance.

Supervisory Conferences. 13 min., 16 mm., sd., b&w.

Summary: This film presents the supervisory conference as one method of helping supervisors handle problems in human relations.

Placing the Right Man on the Job. 13 min., 16 mm., sd., b&w. Norwood Films, 926 New Jersey Avenue, NW., Washington, D.C. 20001.

Summary: This film dramatizes the cases of five workers unsatisfactory in their particular jobs, who are reassigned to other jobs which are more suitable to their abilities and capacities.

Supervising Workers on the Job. 10 min., 16 mm., sd., b&w. Norwood Films, 926 New Jersey Avenue, NW., Washington, D.C. 20001.

Summary: This film presents dramatized incidents which illustrate good and poor methods of supervision.

The Supervisor as a Leader, Part I. 14 min., 16 mm., sd., b&w. Norwood Films, 926 New Jersey Avenue, NW., Washington, D.C. 20001.

Summary: This film includes four dramatized episodes which illustrate poor supervisory practices and the importance of the following rules: (1) always keep promises; (2) never take credit for someone else's work; (3) don't pass the buck, and (4) don't play favorites.

The Supervisor as a Leader, Part II. 13 min., 16 mm., sd., b&w. Norwood Films, 926 New Jersey Avenue, NW., Washington, D.C. 20001.

Summary: This film includes four dramatized illustrations of poor supervision and arrives at the following conclusions: (1) be a leader, not an authoritarian, (2) show appreciation for a job well done, (3) do not become angry, and (4) protect the rights and feelings of workers.

Visual aids are also available from Small Business Administration field offices to correlate with the 1965 management publications: *Personnel Management, Vol. 6* and *Human Factors in Small Business, Vol. 10.*

AGRICULTURAL EQUIPMENT TECHNOLOGY SEMINAR II

Hours Required

Class, 1; Laboratory, 0

Description

This course is a continuation of Agricultural Equipment Technology Seminar I. It stresses procedures and practices of job application, adjustment to an employer, supervision and management of employees, and the organizational and legal aspects of agricultural equipment businesses and farm management. These subjects are analyzed and discussed in light of the student's recent summer employment experience, to stimulate his curiosity and interest.

Major Divisions

	Class hours
I. Getting a Job	7
II. Selection, Supervision, and Management of Employees in an Agricul-	

	Class hours
tural Equipment Business or Farm	6
III. Organizational and Legal Aspects of an Agricultural Equipment or Production Enterprise	3
Total	16

I. Getting a Job
  1. Application
    a. Sources of job information
    b. Application procedures and personal résumé
    c. Job interviews
      (1) Dress and grooming
      (2) Interview procedures
    d. Acceptance procedures
  2. Orientation to the job
    a. Pay, benefits, and employment conditions
    b. Company handbook
    c. Supervisor conference and follow-up procedures
II. Selection, Supervision, and Management of Employees in an Agricultural Equipment Business or Farm
  1. Employer-employee relationships
    a. Organizational structure
    b. Personnel policies
    c. Union contracts
    d. Employee performance evaluation
    e. Legal aspects of employer-employee relationships
      (1) Fair Labor Standards Act
      (2) Labor-Management Relations Act
      (3) State labor-management relations acts
      (4) Social Security and pension plans
      (5) Other Federal and State legislation which affects working conditions, safety, health, etc.
  2. Remuneration
    a. Basic kinds of wage and salary plans
    b. Determining wage and salary rates and payments
    c. Fringe benefits
    d. Federal and State wage legislation
III. Organizational and Legal Aspects of an Agricultural Equipment or Production Enterprise
  1. Types of business organizations
    a. Individual
    b. Partnership
    c. Corporation
  2. Insurance for the business
    a. Fire
    b. Liability
    c. Workmen's Compensation
    d. Multiple peril policy
  3. Legal aid for the business
    a. Need for a lawyer
    b. Selection of a lawyer
  4. Contracts in farm production operations
    a. Custom contracting
    b. Purchasing
    c. Selling

Texts and References

Same as for Agricultural Equipment Technology Seminar I

Visual Aids

Same as for Agricultural Equipment Technology Seminar I

AGRICULTURAL EQUIPMENT TECHNOLOGY SEMINAR III

Hours Required

Class, 1; Laboratory, 0

Description

The course is a continuation of Agricultural Equipment Technology Seminar II. It consists of a study of the physical facilities of a farm equipment business, the trade area, and selection of lines of merchandise to be handled in the business. Problems inherent in managing and in working in parts and service departments are considered. This course should improve the student's understanding of the industry in which he may choose to work. If the student will be employed on a farm or as a farm owner, knowledge of the agricultural equipment industry will assist him in his dealings with suppliers and servicemen of agricultural equipment.

Major Divisions

	Class hours
I. Physical Facilities, Trade Area, and Lines of Merchandise	4
II. Management of the Parts Department	6
III. Management of the Service Department	6
Total	16

I. Physical Facilities, Trade Area, and Lines of Merchandise
  1. Importance of location
  2. Determination of potential trade area
  3. Merchandise needs of the area
  4. Facilities
    a. Total space
    b. Building space
    c. Expansion room
  5. Layout
    a. Departmental
    b. Building
    c. Total
  6. Dealer-manufacturer contractual relationships

II. Managment of the Parts Department
  1. Importance and value of quality management
  2. Layout of parts department
  3. Inventory management and control
  4. Selling, advertising, and displays

III. Management of the Service Department
  1. Importance and value of sound management
  2. Labor recovery
  3. Selling service labor
  4. Methods of pricing service labor
  5. Records, facilities, and equipment
  6. Pre-delivery, delivery, and warranty

Texts and References

Same as for Agricultural Equipment Technology Seminar I

Visual Aids

Same as for Agricultural Equipment Technology Seminar I

DRAWING, SKETCHING, AND DIAGRAMING

Hours Required

Class, 1; Laboratory, 2

Description

In this class, the student learns to make accurate sketches, drawings, and diagrams; and he learns to read, understand, and use them. Although the use of basic drawing instruments and drawing aids is taught, the major emphasis is on sketching and plan reading. Neatness should be stressed, but the objective of the course is to develop illustrative and graphic communication skills rather than technical drafting proficiency.

Many of the topics for drawings will reflect problems encountered in the Welding, or the Planting and Tillage Equipment courses, which are studied concurrently with this course. Other topics will be drawn from other courses in the curriculum such as Hydraulics, Agricultural Electricity, and Farm Power.

Major Divisions

	Class hours
I. Sketching of Shapes	3
II. Freehand Lettering	2
III. Sketching of Pictorial Drawings	2
IV. Multiview Drawings	2
V. Schematic Drawings	2
VI. Dimensioning Drawings	2
VII. Instrument Drawings	3
Total	16

I. Sketching of Shapes
  1. Sketching of lines
    a. Horizontal
    b. Vertical
    c. Oblique
  2. Sketching of geometrical designs
    a. Circle
    b. Angles
    c. Square
    d. Rectangle
    e. Hexagon
  3. Alphabet of lines

II. Freehand Lettering
  1. Types of lettering
  2. Freehand techniques

III. Sketching of Pictorial Drawings
  1. Oblique
    a. Principles
    b. Steps in construction
    c. Advantages and disadvantages

    2. Isometric
        a. Principles
        b. Steps in construction
        c. Advantages and disadvantages
    3. Perspective
        a. Principles
        b. Steps in construction
        c. Advantages and disadvantages
    4. Cut-away drawings
        a. Principles
        b. Steps in construction
        c. Advantages and disadvantages
    5. Exploded view drawings
        a. Principles
        b. Steps in construction
        c. Advantages and disadvantages

IV. Multiview Drawings
    1. Principles of orthographic projection
    2. Relationship of views
    3. Selection of views
    4. Invisible surfaces and auxiliary views

V. Schematic Drawings
    1. Principles
    2. Symbols used
        a. Electricity
        b. Hydraulics
        c. Farm building construction
        d. Welding

VI. Dimensioning Drawings
    1. Sizes and location dimensions
    2. Fractional and decimal dimensions
    3. Tolerances
    4. Shop notes
    5. Do's and don'ts of dimensioning

VII. Instrument Drawings
    1. Mechanical drawing equipment
        a. Types
        b. Use
        c. Care
    2. Geometrical construction
        a. Definition of geometrical figures
        b. Use of drawing equipment in construction of geometrical figures

Laboratory—32 Hours

Good workbooks in sketching and in plan reading should be selected. It is desirable to coordinate the plan reading with the sketching, since each reinforces the other. The following laboratory exercises are suggested:

1. Sketching horizontal, vertical, and oblique lines
2. Sketching circles, angles, squares, rectangles, and hexagons
3. Freehand lettering practice
4. Sketching pictorial drawings
5. Sketching multiview drawings
6. Reading multiview plans
7. Dimensioning drawings
8. Reading dimensions on plans
9. Making simple instrument drawings

Texts and References

FLEMING *and others. Applied Drawing and Sketching.*
FRENCH. *Engineering Drawing.*
GIACHINO *and* BEUKEMA. *Freehand Sketching.*
GIESECKE *and others. Technical Drawing.*
LUZADDER *and* HORNUNG. *Technical Drafting Essentials.*
OLIVO *and* PAYNE. *Basic Blueprint Reading and Sketching.*
WALKER *and* PLEVYAK. *Industrial Arts Drafting.*

SELLING, DISTRIBUTING, AND SERVICING

Hours Required

Class, 3; Laboratory, 2

Description

This course is designed to acquaint the student with the procedures and techniques of modern salesmanship, including selected aspects of marketing and the servicing of products. The classroom instructional period will consist primarily of lecture-discussions to present material on the practical aspects of sales training, sales preparations, planning, and sales presentations. Emphasis is placed upon vocabulary and the development of the student's ability in oral expression.

The course is designed to serve as both training for prospective salesmen and as a human relations course. It has been built around the concept that everyone is a "salesman," and that everyone must learn how to "sell" himself and get along with others before he can convince them to make decisions affecting their social, psychological, physical, or economic affairs. It is suggested that sections of the class be limited to 15 to 18 students in order to permit full participation by all students.

Major Divisions

	Class hours
I. The Necessity of Salesmanship	3
II. Motivational Aspects of Buyers	4
III. Sources of Product Information	3
IV. Methods of Presenting Sales Information	3
V. Arranging the Sales Interview	3
VI. Personality and Selling	4
VII. Communication and Selling	3
VIII. Demonstrating a Product	3
IX. Objections of the Buyer	3
X. Organizing the Selling Effort	3
XI. Sales and Credit Extension	3
XII. Distribution	4
XIII. Competition	3
XIV. Public Relations	3
XV. Methods of Closing	3
Total	48

I. The Necessity of Salesmanship
  1. Historical aspects
  2. Product expansion and technology
  3. Personal, social, and economic aspects
  4. Types of sales positions

II. Motivational Aspects of Buyers
  1. Classification of motives
  2. Variation among buying motives
  3. Needs and wants of buyers
  4. "Suspects" and prospects
  5. Consumer habits
  6. Emotional and rational appeals
  7. Types and sources of prospect information
  8. Use of prospect information

III. Sources of Product Information
  1. Manufacturer
  2. Wholesaler
  3. Retail outlets
  4. Libraries
  5. Media
  6. Competition
  7. Publications

IV. Methods of Presenting Sales Information
  1. Planned presentation
  2. Memorized presentation
  3. Customer-designed presentation
  4. Cold canvassing
  5. The pre-approach
  6. The approach

V. Arranging the Sales Interview
  1. Making appointments
  2. Keeping appointments
  3. The secretary and/or receptionist
  4. Initial objectives of the interview
  5. First impressions
  6. Introductions
  7. Topics to avoid

VI. Personality and Selling
  1. Definition
  2. Improvement of personality
  3. Mental and moral characteristics
  4. Social graces
  5. Personality classifications

VII. Communication and Selling
  1. Vocabulary development
    a. Technical
    b. Special
  2. Persuasion
  3. Visual aids
  4. Use of humor
  5. Speaking techniques

VIII. Demonstrating a Product
  1. Techniques in demonstrating
  2. Products
  3. Services
  4. Planning the demonstration
  5. Pitfalls

IX. Objections of the Buyer
  1. Types of objections
  2. Anticipating objections
  3. Welcoming objections
  4. Answering objections

X. Organizing the Selling Effort
  1. Planning
  2. Organization of time
  3. Recordkeeping
  4. Health and habits
  5. Review of selling efforts
  6. Goals

XI. Sales and Credit Extension
  1. Relationships of sales and credit departments
  2. Credit policies
  3. Building of accounts
  4. Maintenance of accounts
  5. Building of good will
  6. Credit and collection

XII. Distribution
  1. Channels of trade
  2. Financing

    3. Wholesaling
    4. Pricing policies
    5. Franchise operations
    6. Cooperatives
    7. Selling parts
    8. Selling service
    9. Government regulations

XIII. Competition
    1. Attitudes toward
    2. Knowledge of competitors
    3. Utilizing information about competitors
    4. "Knocking" competitors
    5. Product comparison
    6. Avoiding errors

XIV. Public Relations
    1. Advertising
    2. Sales promotion
    3. Budgetary considerations
    4. Philosophical considerations
    5. Good will

XV. Methods of Closing
    1. Trial closes
    2. Attitudes of buyer
    3. Closing difficulties
    4. Techniques of closing
    5. Return calls

Laboratory—32 Hours

The laboratory segment of this course is devoted primarily to oral sales presentations which are based on material and information gathered by each student. Initial laboratory sessions should provide each student with an opportunity to speak before the class. Topics are usually selected by the student. Oral presentations are usually limited to 3 to 5 minutes. Some time is used for film showing and other visual aids.

The final oral sales presentation is based upon material and information gathered by each student during the early part of the course. Each student is permitted to select a product in which he has a particular interest. He is then required to gather all data necessary to "sell" this product to a "buyer." All data and material are organized into a selling program, and an oral presentation is developed from these data. The purpose of preparing the oral presentation is to teach the student to organize and utilize the data in a sales presentation. This preparation identifies questions and objections which might be raised by a customer and the ways they might be answered; it also stresses the important selling points of the product.

Information necessary in the preparation of the sales canvass includes the history of the company and the product; and the distribution, competition, uses, and advantages of the product.

The laboratory time may be divided between the following activities:

1. Oral speeches and critiques
2. Visual aids
3. Oral sales presentations

Texts and References

Bennett. *The Power of Inspired Salesmanship.*
Berton. *The Big Sell.*
Blumenthal. *Great Sales by Today's Great Salesmen.*
Canfield. *Salesmanship Practices and Problems.*
Greif. *Modern Salesmanship.*
Grossack. *Understanding Consumer Behavior.*
Haas. *Professional Salesmanship.*
Hattwick. *The New Psychology of Selling.*
Kirkpatrick. *Salesmanship.*
MacDonald. *Strategies That Close Sales.*
Pederson *and* Wright. *Salesmanship, Principles and Methods.*
Raux. *Salesman's New Complete Ideas Handbook.*
Roth. *How to Find and Qualify Prospects and Get Interviews.*
Shaw *and* Thompson. *Salesmanship.*
Thompson. *Selling, A Behavioral Science Approach.*
Thompson. *Salesmanship: Concepts, Management, and Strategy.*
Tosdal. *Selling in Our Economy.*
Weiss. *The Vanishing Salesman.*

Visual Aids

Approach. 10 min., 16 mm., sd., b&w. McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York, N.Y. 10036.

Summary: This animated film emphasizes the importance of the well-planned sales interview. It stresses the importance of both physical appearance and knowledge in securing and maintaining the prospect's attention and interest.

Importance of Selling. 20 min., 16 mm., sd., b&w. Encyclopedia Britannica Films, Inc., 1150 Willmette Ave., Willmette, Ill. 60091.

Summary: This film concerns sales and services in a modern-day business firm. It emphasizes the importance of selling in our economy.

Making That Sale. 14 min., 16 mm., sd., b&w. McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York, N.Y. 10036.

Summary: This film illustrates techniques for closing sales. It shows the importance of the demonstration, especially in promoting consumer confidence. Handling of customer objections is also discussed.

Pre-approach. 10 min., 16 mm., sd., b&w. McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York, N.Y. 10036.

Summary: This film stresses the importance of preparation by the salesman before meeting the customer. It also illustrates how plans can be changed to better meet the needs and motives of the customer.

Prospecting. 10 min., 16 mm., sd., b&w. McGraw-Hill Book Co., Inc., 330 West 42nd Street, New York, N.Y. 10036.

Summary: In this film, three salesmen are interviewed to determine their techniques for finding prospects. Each provides insights into a different technique.

Selling as a Career. 11 min., 16 mm., sd., b&w. Sales Department, Coronet Films, Coronet Building, Chicago, Ill. 60601.

Summary: This film explores the activities of a salesman primarily from the standpoint of one who is choosing a career.

Selling Your Personality. 7 min., 16 mm., sd., b&w. International Film Bureau, 332 S. Michigan Ave., Chicago, Ill. 60604.

Summary: This film shows right and wrong ways of selling. It demonstrates how interest in the customer and observance of social graces help make sales.

Success Story. 9 min., 16 mm., sd., b&w. International Film Bureau, 332 S. Michigan Ave., Chicago, Ill. 60604.

Summary: This film concerns retail selling as a career. Advancement up the career ladder from sales clerk to buyer is shown.

TECHNICAL REPORTING

Hours Required

Class, 2; Laboratory, 0

Description

This course is a natural and vital extension of Communication Skills; it is intended to help the student achieve greater facility in his use of the language, both spoken and written. Using the basic skills previously acquired, the student is introduced to the practical aspects of preparing reports and communicating within groups. The use of graphs, charts, sketches, diagrams, and drawings to present ideas and significant points is an important part of this course.

Emphasis is placed upon techniques for collecting and presenting scientific data by means of informal and formal reports and special types of technical papers. Forms and procedures for technical reports are studied, and a pattern is established for all forms to be submitted in this and other courses.

Much of the subject matter of this course may be necessary reports written for technical courses. The subject matter taught in this course should be related to that of the course Drawing, Sketching and Diagraming studied in the first semester.

Major Divisions

	Class Hours
I. Reporting	3
II. Writing Technical Reports	12
III. Illustrating Technical Reports	4
IV. The Research Paper	3
V. Oral Reporting	4
VI. Group Communication and Participation	6
Total	32

I. Reporting
  1. Nature and types of reports
  2. Objective reporting
  3. The problem concept
  4. The scientific method
    a. Meaning of the method
    b. Characteristics of the scientific method
    c. Essentials of scientific style
    d. Importance of accuracy and intellectual honesty in observation and recording
    e. Legal importance of recorded data and log books
  5. The techniques of exposition
    a. Definitions
    b. Progression
    c. Elements of style
    d. Analysis of examples
    e. Methods of slanting a report
  6. Critical evaluation of a report
II. Writing Technical Reports
  1. Characteristics of technical reports
  2. Report functions
  3. Short informal reports
    a. Memorandum reports

  b. Business letter reports
  c. Progress reports
  d. Outline reports
4. Formal reports
  a. Arrangement
    (1) Cover and title page
    (2) Table of contents
    (3) Summary or abstracts
    (4) Body of the report
    (5) Bibliography and appendix
    (6) Graphs, drawings, or other illustrations
  b. Preparation
    (1) Collecting, selecting, and arranging material
    (2) Writing and revising the report
5. Special types of papers
  a. The abstract
  b. Process explanations
  c. The case history
  d. The book review

III. Illustrating Technical Reports
1. Illustrations as aids to brevity and clarity
2. Use of technical sketching and drawings
3. Use of pictorial drawings and sketches
4. Use of a diagrammatic representation
  a. Electrical diagrams and symbols
  b. Process flow diagrams
  c. Instrumentation diagrams
  d. Bar charts, pie diagrams, and similar presentation of data
5. Graphical presentation of data
  a. Types of graph paper
  b. Choice of scale for graphs
  c. Points and lines
  d. Use of data from graphs
6. Use of photographs
7. Selection of appropriate illustrations
  a. Availability
  b. Cost of preparation
  c. Maximum brevity and clarity of presentation

IV. The Research Paper
1. Subject and purpose
2. Source materials
  a. Bibliographical tools
  b. Periodical indexes
  c. The library
3. Organizing the paper
  a. A working bibliography
  b. Notes and the outline
  c. The rough draft
  d. Quoting and footnoting
  e. The final paper
4. Oral and written presentation of the paper

V. Oral Reporting
1. Organization of material for effective presentation
2. Formal and informal reports
3. Use of notes
4. Use of slides, exhibits
5. Proper use of the voice
6. Elimination of objectionable mannerisms
7. Introduction

VI. Group Communication and Participation
1. The problem-solving approach
  a. Stating and analyzing the problem
  b. Proposing solutions
  c. Selecting and implementing a solution
2. Participating in group communication
  a. The chairman—duties and qualification
  b. Rules of order
  c. The panel discussion and symposium
  d. Group investigation

Texts and References

Brown. *Casebook for Technical Writers.*
Corbin and **Perrin.** *Guide to Modern English.*
Crispin. *Dictionary of Technical Terms.*
Crouch and **Zetler.** *A Guide to Technical Writing.*
Dean and **Bryson.** *Effective Communication.*
Estrin. *Technical and Professional Writing: A Practical Anthology.*
Fowler. *A Dictionary of Modern English Usage.*
Hays. *Principles of Technical Writing.*
Luzadder. *Graphics for Engineers.*
Mantell. *Engineering Materials Handbook.*
Menzel and others. *Writing a Technical Paper.*
Nicholson. *A Dictionary of American-English Usage.*
Schutte and **Steinberg.** *Communication in Business and Industry.*
Sherman. *Modern Technical Writing.*
Sigband. *Effective Report Writing.*
Souther. *Technical Report Writing.*
Strunk. *The Elements of Style.*

AMERICAN INSTITUTIONS

Hours Required

Class, 3; Laboratory, 0

Description

This course is based upon the premise that each technician is responsible for making a productive contribution toward the perfection and perpetuation of the American way of life; to do so he must know and understand his responsibilities and obligations to himself, his family, his community, his State, his Nation, and the world. The salient elements of American institutions are covered to help the student understand his total environment and the forces which interact to form the social setting in which he works and lives.

Major Divisions

	Class hours
I. Introduction to Political Science	2
II. American Government	12
III. Social Institutions	12
IV. Human Ecology: Population	6
V. Dynamics of the Labor Force	12
VI. Current Government Programs	4
Total	48

I. Introduction to Political Science
  1. Examination of the growth of that institution known as "government"
  2. Political philosophers with emphasis on Hobbes, Locke, and Rousseau

II. American Government
  1. Constitutional bases for Federal, State, and local governmental relationships
    a. Federation—confederation
    b. Compact of States theory
  2. Political parties and pressure groups
    a. Nominating conventions and election campaigns
    b. Party discipline
    c. Lobbies and vested interest groups
    d. Other political forces and tactics
  3. Organization and function of legislative branch
    a. Minority and majority floor leaders
    b. Whips
    c. Committee organizations
    d. Other
  4. Organization and function of executive branch
    a. Cabinet
    b. Executive staff and assistants
    c. Executive agencies
  5. The Federal Court system
    a. District
    b. Appellate
    c. Supreme
    d. Special
  6. Responsibilities of citizens in a democracy
    a. Understanding propaganda
    b. Becoming informed on public affairs
    c. Voting
    d. Running for office
    e. The public good
  7. International relations and world problems
    a. United Nations
    b. Treaties
    c. Mutual security pacts or agreements
    d. Alliances
    e. Current events
    f. Technical assistance, such as mutual aids in economics, agriculture, education

III. Social Institutions
  1. Our culture: its improvement and perpetuation
  2. Relationship of individuals to social institutions
    a. Home
    b. Public and private educational institutions
    c. The community
    d. Church
    e. Organized social groups—fraternal, labor, business, and professional
    f. Government
    g. Other
  3. Forces of social disorganization

IV. Human Ecology: Population
  1. Social and cultural aspects of population change
  2. Effect of advancing technological gains on American life
  3. National and world food and fiber needs and supply

V. Dynamics of the Labor Force
  1. Labor supply and the market
    a. Level and composition of the labor force
    b. Changing patterns of employment
  2. Control of employment
    a. Types of employment
    b. Proposed schemes of employment stabilization
    c. Continuing problems
  3. Labor mobility
    a. Types
    b. Deterrents
    c. Suggested programs for improvement
  4. Wage structures
    a. Occupational differences
    b. Geographic patterns
    c. Industry patterns
    d. Wage determination
      (1) Plant levels
      (2) Individual job wages
  5. Wages and the national income
    a. Productive process
    b. Concepts of measurement and productivity
    c. Determinants of productivity
    d. Distribution of national income
    e. The problem of inflation

VI. Current Government Programs
  1. Foreign aid
  2. Agriculture
  3. Poverty
  4. Peace Corps
  5. Other

Texts and References

BIESANZ *and* BIESANZ. *Modern Society.*

BIERSTEDT. *The Social Order.*

B ERSTEDT *and others. Modern Social Science.*

OYD *and* WORCESTER. *American Civilization.*

CHINOY. *Society: An Introduction to Sociology.*

COSER. *Sociology Through Literature.*

HUNT. *Social Science: An Introduction to the Study of Society.*

MEAD *and* MEAD. *Man Among Men: An Introduction to Sociology.*

MERRILL. *Society and Culture: An Introduction to Sociology.*

MOTT. *The Organization of Society.*

O'BRIEN *and others. Readings in General Sociology.*

OGBURN *and* NIMKOFF. *Sociology.*

ROSS *and* VAN DEN HAAG. *The Fabric of Society.*

WATSON *and* FARR. *The Social Sciences and American Civilization.*

Visual Aids

Color of Man. 10 min., 16 mm., sd., color. UCLA, Los Angeles, Calif. 90024.

Summary: This film explains the physiological reasons for skin color and the social significance of these differences.

The Constitution Series. 3 parts, 6 min. each, sd., b&w. Text-Film Dept., McGraw-Hill Book Co., Inc., 330 W. 42d St., New York, N.Y. 10036.

Summary: This film tells the story of the creation and growth of the U.S. Constitution.

Learning About the Past. 10 min., 16 mm., sd., b&w. National Educational TV Film Source, Audio-Visual Center, Indiana University, Bloomington, Ind. 47401.

Summary: This film demonstrates methods used by archaeologists to discover, excavate, study, and interpret a buried prehistoric American Indian culture.

Marriage Today. 22 min., 16 mm., sd., b&w. Text-Film Dept., McGraw-Hill Book Co., Inc., 330 W. 42d St., New York, N.Y. 10036.

Summary: This film depicts two couples who have made their marriages work through cooperation and analysis of their mutual aims. Their ideals and goals are in true perspective; they are willing to work together to reach them.

One People. 11 min., 16 mm., sd., color. Anti-Defamation League of B'nai B'rith, 315 Lexington Ave., New York, N.Y. 10016.

Summary: This film outlines the contributions of various nationality groups to American life.

COMMUNICATION SKILLS

Hours Required

Class, 3; Laboratory, 0

Description

This course is based on the premise that communication is basically a thinking act. The effective communicator must be prepared to deal with the two major aspects in communication: his own thinking as a reader or listener, and the thinking of the writer or speaker as he uses ideas and the materials of expression.

Emphasis should be placed upon exercises in writing, speaking, reading, and listening. These exercises are designed to reinforce the basic principles of communication theory presented.

Each student's strengths and weaknesses in such areas as grammar and usage should be analyzed and the pattern of instruction should be designed to help individual students improve skills in areas where weaknesses are found.

Major Divisions

	Class hours
I. Introduction to Communication	3
II. Communication: Development of Ideas	9
III. Communication: Analysis and Arrangement of Ideas	9
IV. Communication: Presentation of Ideas	9
V. Communication and the Thought Process	18
Total	48

- I. Introduction to Communication
  - 1. Nature and scope
  - 2. Major purposes
    - a. Information
    - b. Persuasion
    - c. Conviction
    - d. Inquiry
    - e. Entertainment
  - 3. The communication process
    - a. Communication source
    - b. Encoder
    - c. Message
    - d. Channel
    - e. Decoder
    - f. Communication receiver
  - 4. Levels of communication
    - a. Interpersonal
    - b. Intergroup
    - c. Mass
- II. Communication: Development of Ideas
  - 1. Definition of data
  - 2. Nature of data
    - a. Primary sources
      - (1) Sampling and sampling methods
      - (2) Questionnaires
      - (3) Interviews
      - (4) Company records
    - b. Secondary sources
      - (1) Library
        - (a) Library classification systems
        - (b) Card catalog
        - (c) Reference volumes
          - i. Dictionaries
          - ii. Encyclopedias
          - iii. Annuals
          - iv. Biographical works
          - v. Guides to books and periodicals in print
          - vi. Indexes to periodicals
            - (i) *Business Periodicals Index*
            - (ii) *Applied Science and Technology Index*
            - (iii) *Industrial Arts Index*
            - (iv) *Engineering Index*
            - (v) *Agricultural Index*
            - (vi) *Engineering Index Annual*
          - vii. Government documents
          - viii. General directories
            - (i) Names and addresses of manufacturers, suppliers, or dealers in a specific field of interest
            - (ii) Service and product listings
          - ix. Business or trade directories
      - (2) Other
      - (3) Recording secondary source data
        - (a) Bibliographical entries
        - (b) The technique of taking notes
        - (c) Note card content
        - (d) Types of notes
          - i. Précis or summary
          - ii. Paraphrase
          - iii. Quotation
          - iv. Critical
        - (e) Documentation of material
- III. Communication: Analysis and Arrangement of Ideas
  - 1. Nature of analysis

2. Patterns of content analysis
    a. Descriptive
    b. Historical
    c. Problem-solving
    d. Logical
    e. Psychological
3. Audience analysis
    a. Planning the message
        (1) Delimitation of topic
        (2) Formulation of specific purpose
        (3) Development of major ideas or patterns
        (4) Selection of supporting details
        (5) Choice of language
    b. Evaluation of message effects
    c. Approaches to audience analysis
        (1) Demographic analysis
        (2) Purpose-oriented analysis
4. Arrangement of material
    a. Topical
    b. Spatial
    c. Chronological
    d. Problem-solution
    e. Causal
    f. Psychological
5. Patterns of outlining
    a. Coordination
    b. Subordination
    c. Sequence
    d. Symbolization

IV. Communication: Presentation of Ideas
1. Style to attain clarity
    a. Purposeful introduction
    b. Appropriate word selection
    c. Simplicity of sentence structure
    d. Use of supporting materials
        (1) Definition
        (2) Example
        (3) Illustration
    e. Meaningful transitional materials
    f. Purposeful summaries
2. Style to make a predictable impression
    a. Modes of expression
        (1) Logical
        (2) Emotional
        (3) Ethical
        (4) Artistic
    b. Sentence structure
    c. Emphasis
        (1) Repetition
        (2) Climax
    d. Rhythm
    e. Imagery
3. Qualities to be developed
    a. Accuracy
    b. Simplicity
    c. Propriety
    d. Effectiveness
    e. Economy
    f. Liveliness
4. Contrasts between oral and written styles of discourse

V. Communication and the Thought Process
1. Logic
    a. Induction
    b. Analogy
    c. Causal reasoning
    d. Deduction
2. Emotion and emotional appeals in communication
    a. Problems of emotional appeals in communication
    b. Kinds of emotional appeals
    c. Uses of emotional appeals
3. Ethics and ethical appeals in communication
    a. Problems of ethics in communication
    b. Types of ethical appeals
    c. Uses of ethical appeals
    d. Propriety of ethical appeals

Texts and References

BEARDSLEY. *Thinking Straight.*

BERLO. *The Process of Communication.*

BROWN. *Words and Things.*

CAMPBELL *and* HELPLER. *Dimensions in Communication.*

CASE *and* VARDAMAN. *Mature Reading and Thinking.*

DANCE. *Human Communication Theory: A Book of Readings.*

DEAN *and* BRYSON. *Effective Communication.*

EISENSON *and others. The Psychology of Communication.*

FOWLER. *A Dictionary of Modern English Usage.*

HANEY. *Communication: Patterns and Incidents.*

MCCRIMMON. *Writing with a Purpose.*

NICHOLSON. *A Dictionary of American-English Usage.*

REDDING *and* SANBORN. *Business and Industrial Communication.*

ROBERTS. *Understanding English.*

STRUNK. *The Elements of Style.*

ZELKO *and* DANCE. *Business and Professional Speech Communication.*

ZETLER *and* CROUCH. *Successful Communication in Science and Industry.*

GENERAL AND INDUSTRIAL ECONOMICS

Hours Required

Class, 3; Laboratory, 0

Description

This course introduces the principles of economics and their implications. It is designed to develop the ability to follow a realistic personal budget, to develop intelligent attitudes and practices of consumption, and to help the student understand the relationship between cost control and success in an industrial enterprise. It is suggested that students be encouraged to study examples from the agricultural equipment industry as they learn about industrial cost analysis, competition, creation of demand, economic production, and the related aspects of applied economics.

Major Divisions

		Class hours
I.	Introduction to Basic Economic Concepts	2
II.	Economic Forces and Indicators	3
III.	Natural Resources—The Basis of Production	3
IV.	Capital and Labor	3
V.	Business Enterprise	7
VI.	Factors of Industrial Production Cost	8
VII.	Price, Competition, and Monopoly	5
VIII.	Distribution of Income	3
IX.	Personal Income Management	3
X.	Money and Banking	3
XI.	Government Expenditures: Federal and Local	3
XII.	Fluctuations in Production, Employment, and Income	3
XIII.	The United States Economy in Perspective	2
	Total	48

I. Introduction to Basic Economic Concepts
II. Economic Forces and Indicators
  1. Economics defined
  2. Modern specialization
  3. Increasing production and consumption
  4. Measures of economic activity
    a. Gross national product
    b. National income
    c. Disposable personal income
    d. Industrial production
    e. Employment and unemployment
III. Natural Resources—The Basis of Production
  1. Utilization and conservation
  2. Renewable resources
  3. Nonrenewable resources
  4. Future sources
IV. Capital and Labor
  1. Tools (Capital)
    a. Importance of saving and investment
    b. Necessity for markets
  2. Large-scale enterprise
  3. Labor
    a. Population characteristics
    b. Vocational choice
    c. General education
    d. Special training
    e. Management's role in maintaining labor supply
V. Business Enterprise
  1. Forms of business enterprise
    a. Individual proprietorship
    b. Partnership
    c. Corporation
  2. Types of corporate securities
    a. Common stocks
    b. Preferred stocks
    c. Bonds
  3. Mechanics of financing business
  4. Plant organization and management
VI. Factors of Industrial Production Cost
  1. Buildings and equipment
    a. Initial cost and financing
    b. Repair and maintenance costs
    c. Depreciation and obsolescence costs
  2. Materials
    a. Initial cost and inventory value
    b. Handling and storage costs
  3. Processing and production
    a. Methods of cost analysis
    b. Cost of labor
    c. Cost of supervision and process control

4. Packaging and shipping
5. Overhead costs
6. Taxes
7. Cost of selling
8. Process analysis, a means to lower costs
9. Profitability and business survival

VII. Price, Competition, and Monopoly
   1. Function of prices
   2. Price determination
      a. Competitive cost of product
      b. Demand
      c. Supply
      d. Interactions between supply and demand
   3. Competition, benefits, and consequences
      a. Monopoly and oligopoly
      b. Forces that modify and reduce competition
      c. History of government regulation of competition
   4. How competitive is our economy?

VIII. Distribution of Income
   1. Increasing real incomes
   2. Marginal productivity
   3. Supply in relation to demand
   4. Incomes resulting from production
      a. Wages
      b. Interest
      c. Rents
      d. Profits
   5. Income distribution today

IX. Personal Income Management
   1. Consumption
   2. Budgeting
   3. Credit
   4. Insurance
      a. Life
      b. Health
      c. Casualty
   5. Investment
      a. Savings
      b. Stocks and bonds
      c. Retirement plans
      d. Mutual funds
   6. Social Security

X. Money and Banking
   1. Functions of money
   2. The Nation's money supply
   3. Organization and operation of a bank
      a. Sources of deposits
      b. The reserve ratio
      c. Expansion of bank deposits
      d. Sources of reserves
   4. The Federal Reserve System
      a. Service functions
      b. Control of money supply
   5. Federal Deposit Insurance Corporation

XI. Government Expenditures: Federal and Local
   1. Economic effects
   2. Functions of Government
   3. Analysis of Government spending
   4. Future outlook
   5. Financing Government spending
      a. Criteria of sound taxation
      b. Tax revenues in the United States
      c. Federal and State personal income taxes
      d. Corporate income tax
      e. Property tax
      f. Commodity taxes

XII. Fluctuations in Production, Employment, and Income
   1. Changes in aggregate spending
   2. Output and employment
   3. Other factors affecting economic fluctuations
      a. Cost-price ralationships
      b. Fluctuations in demand for durable goods
      c. Involuntary fluctuation of supply of commodities
      d. Economic effects of war
      e. Inflation and deflation of currency value
      f. Economic effects of inventions and automation
   4. Means of implementing fiscal policy
   5. Government debt
      a. Purposes of Government borrowing
      b. How burdensome is debt?
      c. Problems of debt management

XIII. The United States Economy in Perspective
   1. Recent economic changes
      a. Increased productivity and well-being
      b. Effects of war and depression
      c. New products and industries
      d. Increase in governmental controls
      e. European Common Market
   2. Present economic problems of U.S. economy

    a. The world market—a community of nations
    b. International cooperation
    c. Maintenance of prosperity and progress
    d. Economic freedom and security
3. Communism
    a. Examination of Marx, Engels, and Lenin
    b. Economic gains under Stalin
    c. Economic problems under Khrushchev
    d. Amelioration of communism forced by economic strain
    e. International communism: its rise, its problems, and its future
4. Fascism
5. Socialism
6. Problems common to all economic systems
7. Special economic problems of the United State

Texts and References

DONALDSON *and* PFAHL. *Personal Finance.*
GAMBS *and* KOMISAR. *Economics and Man.*
LYN. *Basic Economic Principles.*

Visual Aids

Capitalism. 10 min., 16 mm., sd., b&w. Coronet Films, Coronet Building, Chicago, Ill. 60601.

Summary: This film introduces important aspects of the capitalistic system: private property, profit, competition, freedom of contract, and free enterprise.

Europe and the Common Market. 51 min., 16 mm., sd., b&w. Carousel Films, Inc., 1501 Broadway, New York, N.Y. 10036.

Summary: This film describes the organization and objectives of the European Common Market.

Productivity—Key to Plenty. 21 min., 16 mm., sd., b&w. Encyclopedia Britannica Films, 1150 Willmette Avenue, Willmette, Ill. 60091.

Summary: This film traces the development of machine power in the United States, emphasizing the fact that machine productivity helped the United States achieve great production, a large income, and a high standard of living.

352-209 O—70——6

FACILITIES, EQUIPMENT, AND COSTS

General Planning of Facilities

Laboratory and related classrooms, offices, and storage facilities for teaching agricultural equipment technology do not present special or unusual conditions peculiar to the technology. Any well constructed building with suitable utilities may be used. However, if a building is to be constructed to house an agricultural equipment technology program, plans should provide for maximum use of portable equipment in order to attain greatest flexibility and use of space.

The agricultural machinery laboratory must be on the ground floor, where the large machinery and other elements or units of equipment and materials can be moved in and out most conveniently.

Adequate laboratory and physical facilities are vital to the program. There must be sufficient space in which to teach the basic principles of agricultural machines. For best learning conditions the number of students in laboratory sections must be limited. Twelve to 15 students in any one laboratory section usually are all that can obtain

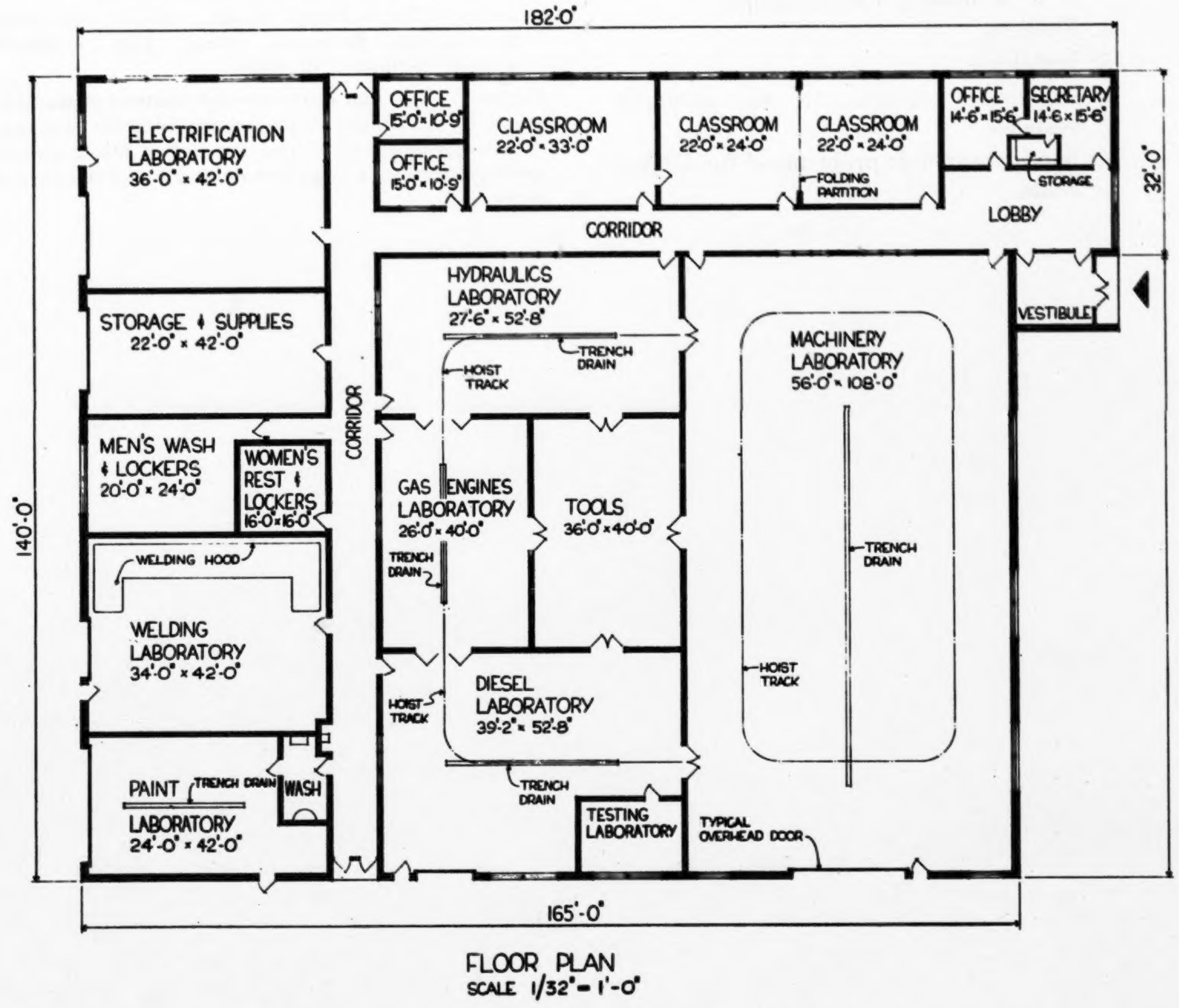

182'-0"
ELECTRIFICATION LABORATORY 36'-0" × 42'-0"
OFFICE 15'-0"×10'-9"
OFFICE 15'-0"×10'-9"
CLASSROOM 22'-0"×33'-0"
CLASSROOM 22'-0"×24'-0"
CLASSROOM 22'-0"×24'-0"
FOLDING PARTITION
OFFICE 14'-6"×15'-6"
SECRETARY 14'-6×15'-6"
STORAGE
LOBBY
32'-0"
CORRIDOR
STORAGE & SUPPLIES 22'-0" × 42'-0"
HYDRAULICS LABORATORY 27'-6" × 52'-8"
TRENCH DRAIN
HOIST TRACK
MACHINERY LABORATORY 56'-0" × 108'-0"
VESTIBULE
CORRIDOR
MEN'S WASH & LOCKERS 20'-0" × 24'-0"
WOMEN'S REST & LOCKERS 16'-0"×16'-0"
GAS ENGINES LABORATORY 26'-0"×40'-0"
TOOLS 36'-0"×40'-0"
TRENCH DRAIN
TRENCH DRAIN
140'-0"
WELDING HOOD
WELDING LABORATORY 34'-0" × 42'-0"
HOIST TRACK
DIESEL LABORATORY 39'-2" × 52'-8"
HOIST TRACK
PAINT LABORATORY 24'-0" × 42'-0"
TRENCH DRAIN
WASH
TRENCH DRAIN
TESTING LABORATORY
TYPICAL OVERHEAD DOOR
165'-0"
FLOOR PLAN
SCALE 1/32" = 1'-0"

Figure 6.—A suggested plan showing classrooms and laboratory layout for agricultural equipment technology.

valuable experiences with one instructor. If the instructor has an assistant, the laboratory section may be enlarged. The following examples and considerations of laboratory space are based on 12 to 15 students per laboratory section.

The suggested classroom space is for 30 to 35 students, because more than that number probably cannot properly observe the parts, models, charts, and operating units used to illustrate the technical specialty courses.

Physical facilities should be carefully planned. Since many of the machines used for instruction will be large, it is imperative that the laboratories have ample floor area, sufficient ceiling clearance, and adequately large doors. Figure 6 illustrates a one-floor plan designed for a separate building. This plan is conveniently and compactly arranged to accommodate large pieces of farm equipment and to decrease the number of utility service lines.

The main laboratory, where overhauling, cleaning, testing, and painting operations will be performed on machinery, should be fireproof or fire resistant masonry or steel frame construction. If a new building is being planned, the cost of wall structures capable of carrying the weight load of an overhead hoist and rail system should be compared with the lighter (and less expensive) wall construction without overhead hoists and rail systems. Most agricultural equipment in the field, and in many dealers' or owners' shops, is overhauled *without* an overhead hoist system. Some machines are designed so that an overhead hoist is ineffective. Floor lifts and A-frame hoists may be the least expensive method for lifting heavy objects. The overhead hoist system provides speed and mobility which is advantageous in a teaching laboratory, but it may cost more than can be justified by the convenience alone. *All agricultural equipment technology students must be trained to work on machinery without overhead hoists*, whether the school laboratory has an overhead system or not.

Doors large enough to permit the passage of large pieces of equipment to and from the laboratories must be provided. The laboratory for large machinery should have a door at least 20 feet wide and 14 feet high. Figure 7 shows a suggested plan for a laboratory of this type. The large overhead doors should be motorized.

Normal environmental control for agricultural equipment technology laboratories and classrooms is necessary. In geographic areas where extremes of warm weather and high humidity prevail for any appreciable part of the year that facilities are to be used, air conditioning of some of the areas has been found to be almost a necessity.

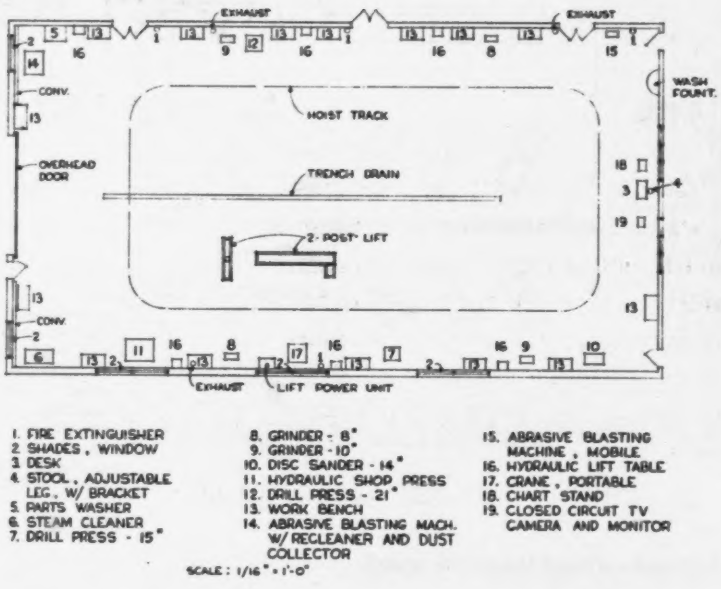

EXHAUST
EXHAUST
WASH FOUNT.
CONV.
OVERHEAD DOOR
HOIST TRACK
TRENCH DRAIN
2-POST LIFT
CONV.
EXHAUST
LIFT POWER UNIT
1. FIRE EXTINGUISHER
2. SHADES, WINDOW
3. DESK
4. STOOL, ADJUSTABLE LEG, W/ BRACKET
5. PARTS WASHER
6. STEAM CLEANER
7. DRILL PRESS - 15"
8. GRINDER - 8"
9. GRINDER - 10"
10. DISC SANDER - 14"
11. HYDRAULIC SHOP PRESS
12. DRILL PRESS - 21"
13. WORK BENCH
14. ABRASIVE BLASTING MACH. W/ RECLEANER AND DUST COLLECTOR
15. ABRASIVE BLASTING MACHINE, MOBILE
16. HYDRAULIC LIFT TABLE
17. CRANE, PORTABLE
18. CHART STAND
19. CLOSED CIRCUIT TV CAMERA AND MONITOR
SCALE: 1/16" = 1'-0"

Figure 7.—Machinery laboratory layout.

It is desirable that a classroom be near the laboratories. Classrooms and laboratories should be well lighted with a recommended minimum of 50-foot-candles of light at the work table or desk tops. Fluorescent lighting is satisfactory.

Hot and cold water, and fuel gas service lines to the laboratories should be planned for the shortest length of piping consistent with laboratory arrangement. They should be hidden as far as practicable, but control points should be planned for safety, accessibility, and ease of maintenance. It is recommended that each laboratory have a master control panel with shut-off valves for each utility.

Laboratory floors should be grease resistant and impervious to water. Sealed concrete, which meets these requirements and provides support for heavy machines, is probably the best construction material for the floors.

Since the best method to clean floors usually is to flush them with water, there should be ready access to water at various locations in the laboratory. Provision must also be made for proper water drainage. Some type of continuous floor drain, as shown in Figures 7 and 8, is preferred, since it allows for efficient and rapid cleaning.

Facilities for the easy and safe lifting of heavy equipment or parts are essential. These facilities

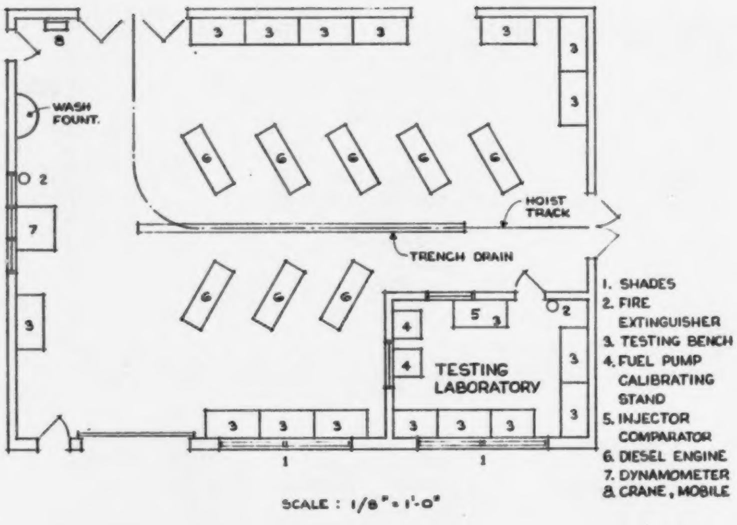


Figure 8.—Diesel laboratory layout.

may consist of various types of floor lifts or ceiling hoists. Motorized hoists on overhead tracks, designed to reach the entire laboratory floor area, are convenient. Figure 9 illustrates one method of using an overhead hoist on an I-beam track. This method permits elevation as well as quick movement of the object to another location within the laboratory.

Provisions for exhausting fumes from operating engines must be made to insure safety, general cleanliness, and the physical comfort of the personnel. This can be accomplished by individual exhausting devices or through a central exhaust system. In a laboratory or shop, it is important to provide specialized areas for each of the various activities performed or subject areas studied. For example, there must be an isolated room provided in the diesel laboratory so that filtered air may be forced into the room with a slight positive to insure a clean atmosphere. This area may be a small room in the corner of the large laboratory, such as the testing laboratory shown in figure 8. The area provided need not be large, since it will be used primarily for testing and calibrating, using relatively small testing devices. Figure 10 is an example of a test stand for calibrating diesel fuel pumps.

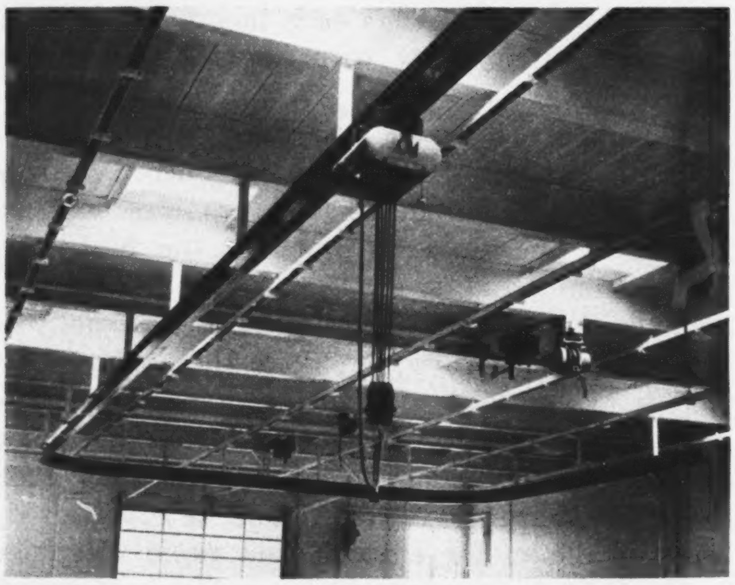


Figure 9.—Example of an overhead hoist on an I-beam track.

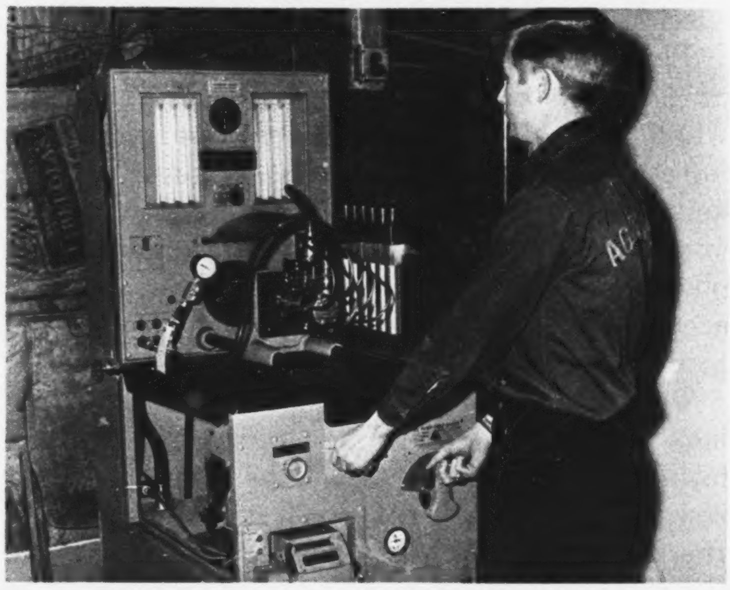


Figure 10.—Equipment for calibrating a diesel fuel pump.

In the diesel testing area, there should be bench space to accommodate eight students working with nozzles, injectors, and pumps. Benches should be metal, and have rolled edges to prevent solvents from dripping on the floor. A metal backboard may aid in keeping the walls clean. Figure 11 illustrates the types of tools and test equipment necessary for the complete servicing of diesel engine injection pump nozzles.

The paint room must be separated from other rooms and equipped with a large door (as shown in fig. 12), to accommodate large farm machines which are to be painted. The paint room must have its own completely efficient and safe exhaust system and must provide a dust-free environment. Only explosion-proof electrical devices may be used in the painting area. Figure 13 shows a satisfactory location of the fan in a cleaning and painting area. As with the diesel laboratory, the room must have an adequate drainage system and a sufficient water supply. Figure 14, which shows a method of cleaning equipment preparatory to painting which utilizes a large volume of water, illustrates the need for adequate drainage.

Figure 11.—Equipment and space must be provided so every student can practice testing and servicing diesel engine injection nozzles.

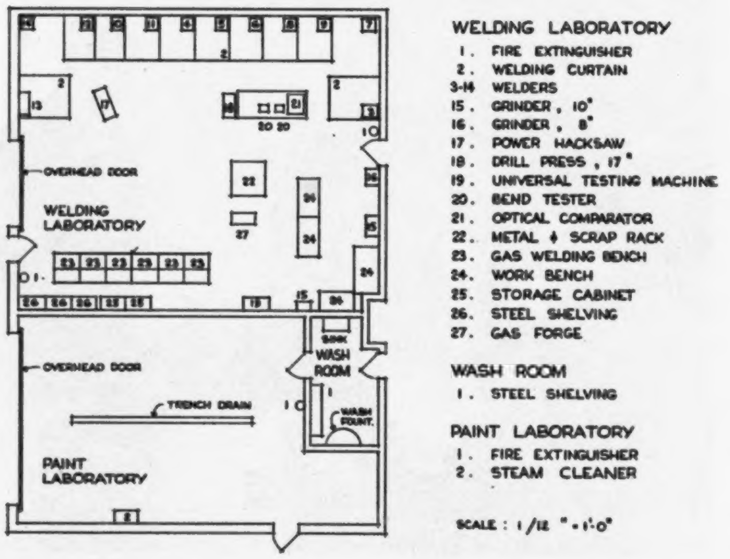

OVERHEAD DOOR
WELDING LABORATORY
OVERHEAD DOOR
TRENCH DRAIN
PAINT LABORATORY
SINK
WASH ROOM
WASH FOUNT.
WELDING LABORATORY
1. FIRE EXTINGUISHER
2. WELDING CURTAIN
3-14 WELDERS
15. GRINDER, 10"
16. GRINDER, 8"
17. POWER HACKSAW
18. DRILL PRESS, 17"
19. UNIVERSAL TESTING MACHINE
20. BEND TESTER
21. OPTICAL COMPARATOR
22. METAL & SCRAP RACK
23. GAS WELDING BENCH
24. WORK BENCH
25. STORAGE CABINET
26. STEEL SHELVING
27. GAS FORGE
WASH ROOM
1. STEEL SHELVING
PAINT LABORATORY
1. FIRE EXTINGUISHER
2. STEAM CLEANER
SCALE: 1/12" = 1'-0"

Figure 12.—Welding laboratory and paint laboratory layout.

Figure 13.—A good painting facility is needed. Note fume exhaust fan in the back wall.

Figure 14.—A steam cleaning and hot water washing unit such as shown here ensures satisfactory cleaning of equipment prior to painting.

Welding requires a fire resistant laboratory which is adequately ventilated for the immediate removal of welding fumes. The welding gas supply tanks should be stored outside the building and the gas piped inside to the welding equipment in the interest of space conservation and safety. It is important to have sufficient lighting for each student station in this laboratory. An equivalent of 75-foot candles of light at bench-top level is recommended. The student stations should be separated from each other, preferably by fireproof curtains, as shown in figure 15, to afford each student adequate protection and to permit greater flexibility in the work area. Figure 15 shows an individual work station for a student practicing welding on a typical home-made bench. This station is separated from the adjoining one by a fireproof curtain as recommended.

A carefully planned laboratory for teaching hydraulics is very important. See figure 16 for suggested layout. Since this facility is used for teaching fluid hydraulics—both oil and water—it must have adequate taps, drains, and space for testing and working with water pumps. Work stations for oil hydraulics should be equipped with sheet steel on bench tops, and trays to retain the oil should be provided. There must also be adequate and clean storage space for the various kinds of hydraulic fluids which will protect the fluid from contamination. A hydraulic tester, such as that shown in figure 17, is necessary in diagnosing the components and circuits of a tractor hydraulic system. A hydraulic training unit, similar to the one shown in figure 18, is useful in teaching principles of hydraulics, control of hydraulic power, and components and circuitry.

The laboratory for teaching the use of electricity and electrical controls should contain both single- and 3-phase service. See figure 19 for suggested layout. Student work stations should be wired for both 120- and 240-volt current so that various kinds of circuits can be assembled. Plywood panels are desirable for wiring exercises in order that students can learn approved wiring practices. Number 2 in figure 19 illustrates a permanent type of panel installation which is near the wall but sufficiently distant from it to enable the students to work on both sides. A framework resembling a picture frame is mounted on metal posts and accommodates 4′ x 8′ sheets

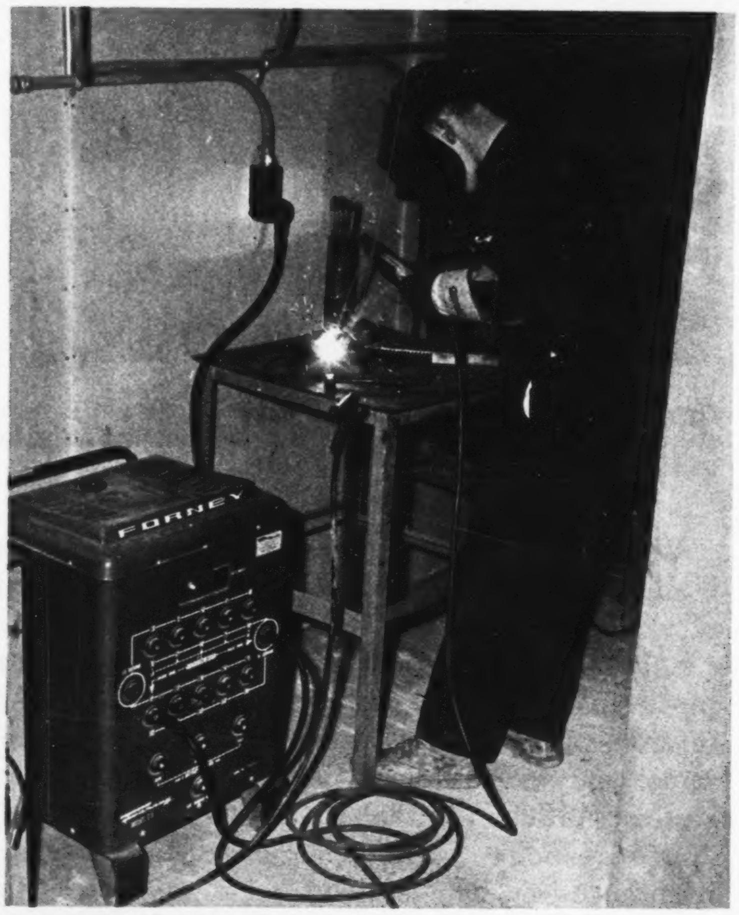


Figure 15.—A typical welding station. Note the fireproof welding arc shielding curtain at the student's right which separates this station from the next.

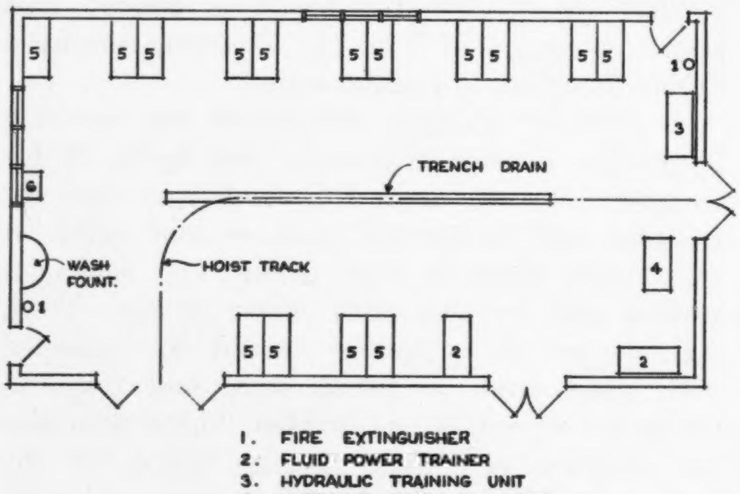

5
5 5
5 5
5 5
5 5
5 5
1
3
6
TRENCH DRAIN
WASH FOUNT.
HOIST TRACK
4
1
5 5
5 5
2
2
1. FIRE EXTINGUISHER
2. FLUID POWER TRAINER
3. HYDRAULIC TRAINING UNIT
4. HYDRAULIC TRACK PIN PRESS
5. STUDENT STATION BENCHES
6. FLUID CIRCUIT SYSTEM

Figure 16.—Hydraulics and pump laboratory layout.

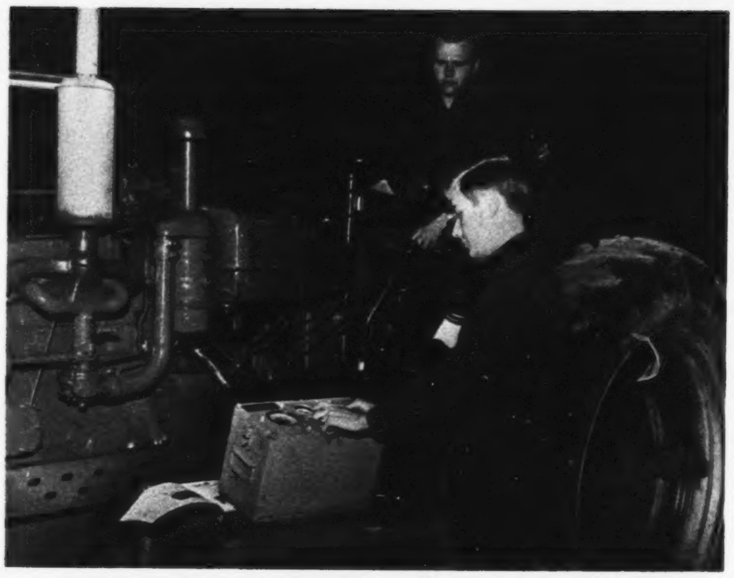


Figure 17.—A hydraulic component tester such as shown here is necessary to give students experience in the diagnosis and adjustment of hydraulic equipment.

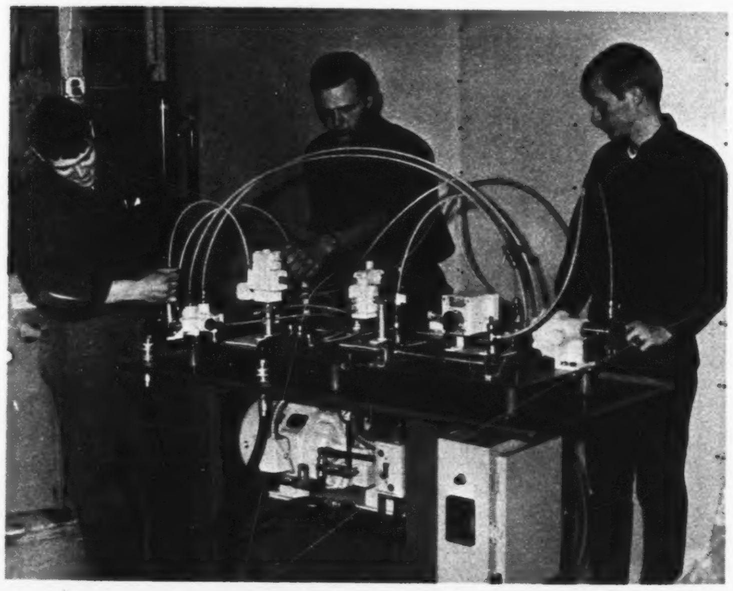


Figure 18.—A hydraulic training unit used to teach the principles of hydraulic circuitry and controls.

of plywood. Screws secure the plywood to the frame to facilitate replacement when the plywood is no longer functional.

Since the electrical laboratory is used for teaching principles of farm mechanization, it should have space for large pieces of equipment as well as space for demonstrating, testing, and setting up operational units. A liberal water supply and numerous electrical outlets, including both 110-volt and 220-volt, single- and 3-phase current, must be available. In farm mechanization, testing devices should be provided for the most representative elements of the program. Examples are found in figure 20, which shows the testing of a complex control system on a pipe-line milker installation, and in figure 21, which illustrates a testing device which may be used to measure the vacuum in milking equipment.

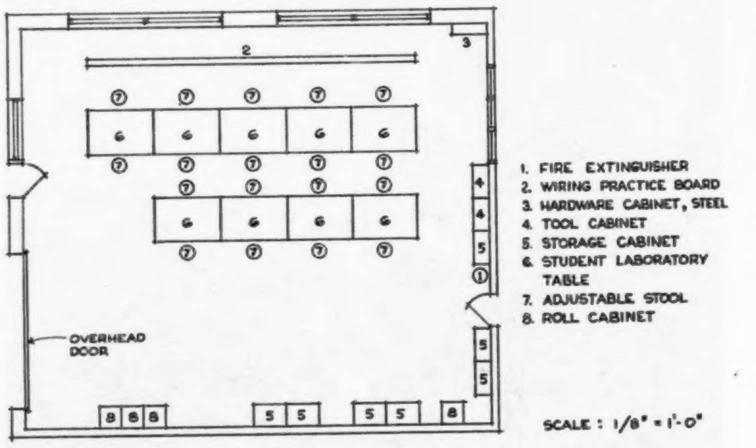


Figure 19.—Electrification laboratory layout.

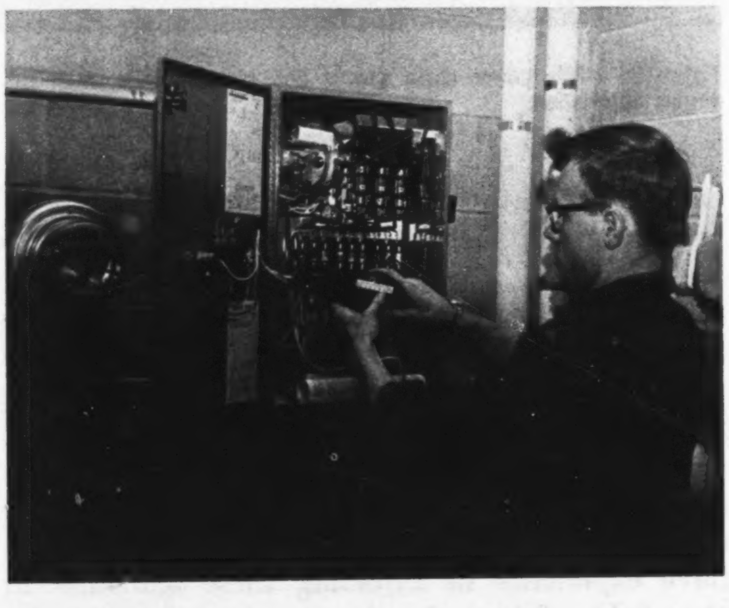


Figure 20.—Diagnostic instruments are required to teach students how to test electrical circuitry such as shown here.

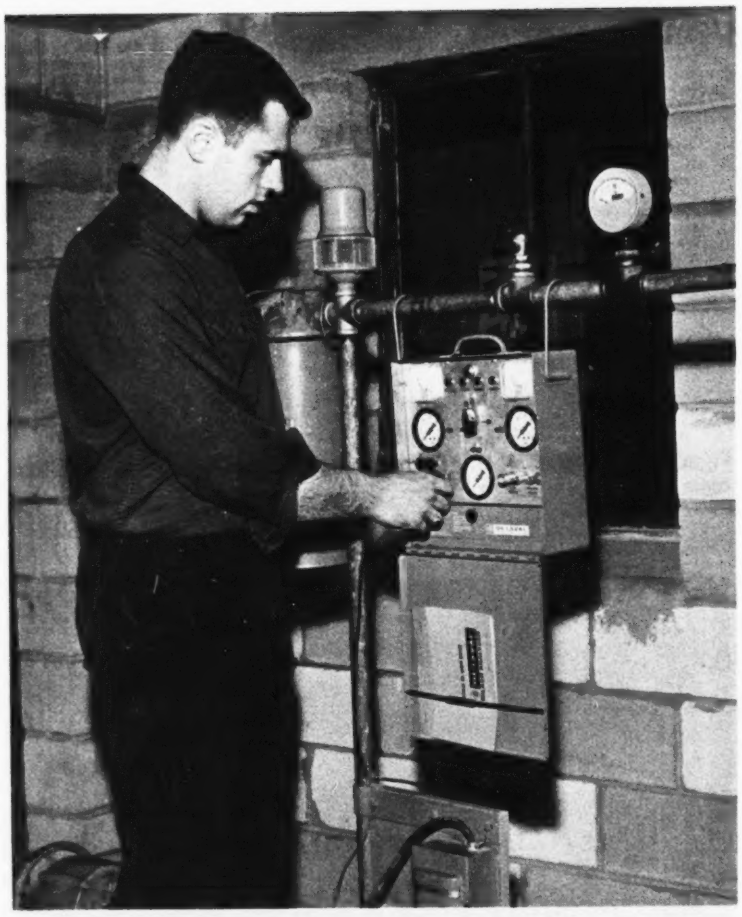


Figure 21.—Vacuum testing equipment is required to check and adjust such units as this automatic milking system.

The laboratory for gas engines and tractors must be carefully planned. Figure 22 illustrates such a laboratory. Adequate lighting must be provided and should include portable lights and convenience outlets. Since many different types of engines and tractors will be tested, there must be numerous exhaust outlets which are flexible enough to provide for 10 or 12 engines placed in various temporary arrangements. Space must be available for performing engine service procedures, engines and components disassembly, repair, and reassembly. Hoisting and jacking equipment, engine positioning stands, work benches, and service tool centers must be used, so maximum flexibility in the use of space should be planned.

Specialized tools and equipment should be kept in an adjacent tool storage room such as shown in figure 22. Equipment should be portable insofar as possible. The following are easily rolled to any work station from the storage area: the electrical system testing unit shown in figure 23, the valve refacer shown in figure 24, and the portable dynamometer depicted in figure 25, which is used inside and outside of the laboratory. The gasoline

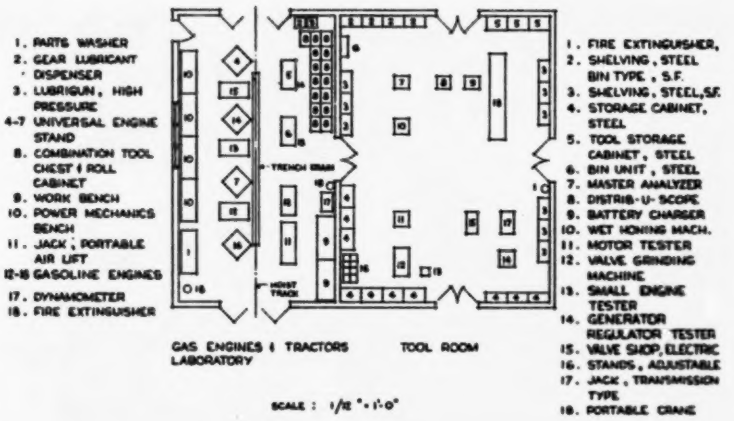

1. PARTS WASHER
2. GEAR LUBRICANT DISPENSER
3. LUBRIGUN, HIGH PRESSURE
4-7 UNIVERSAL ENGINE STAND
8. COMBINATION TOOL CHEST & ROLL CABINET
9. WORK BENCH
10. POWER MECHANICS BENCH
11. JACK, PORTABLE AIR LIFT
12-16 GASOLINE ENGINES
17. DYNAMOMETER
18. FIRE EXTINGUISHER
TRENCH DRAIN
HOIST TRACK
GAS ENGINES & TRACTORS LABORATORY
TOOL ROOM
SCALE : 1/12" = 1'-0"
1. FIRE EXTINGUISHER,
2. SHELVING, STEEL BIN TYPE, S.F.
3. SHELVING, STEEL, S.F.
4. STORAGE CABINET, STEEL
5. TOOL STORAGE CABINET, STEEL
6. BIN UNIT, STEEL
7. MASTER ANALYZER
8. DISTRIB-U-SCOPE
9. BATTERY CHARGER
10. WET HONING MACH.
11. MOTOR TESTER
12. VALVE GRINDING MACHINE
13. SMALL ENGINE TESTER
14. GENERATOR REGULATOR TESTER
15. VALVE SHOP, ELECTRIC
16. STANDS, ADJUSTABLE
17. JACK, TRANSMISSION TYPE
18. PORTABLE CRANE

Figure 22.—Layout of gas engines and tractors laboratory and tool room.

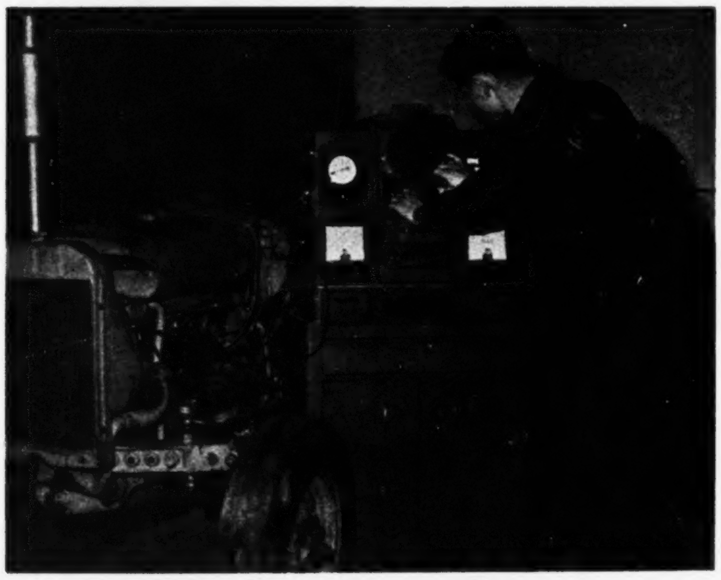


Figure 23.—A gasoline engine electrical system test unit is required.

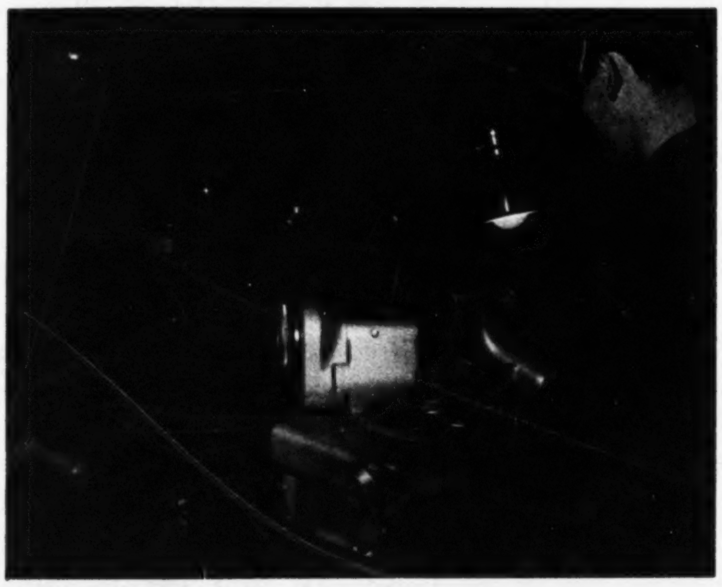


Figure 24.—A valve refacer is one of several necessary equipments in an engine laboratory.

Figure 25.—A portable dynamometer such as this unit should be available because students must learn to do field testing of tractor performance.

Figure 26.—This power chain saw is one example of a small gas engine application.

engines laboratory is also used for the study of small engines, such as those shown in figures 26 and 27.

As stated earlier, it is important to provide facilities for the field operation of the various farm and light industrial machines which are studied. Acreages should be large enough so that each student has the opportunity to operate power equipment machines such as the grain combine, under field conditions. Students must have experience in adjusting these machines in the field. Instructional situations should be typical of the specific geographic location in which the program is operating. It is also important to have a wide choice of representative makes and designs of machines. Figures 28 and 29 show some of the instructional situations using equipment under field conditions.

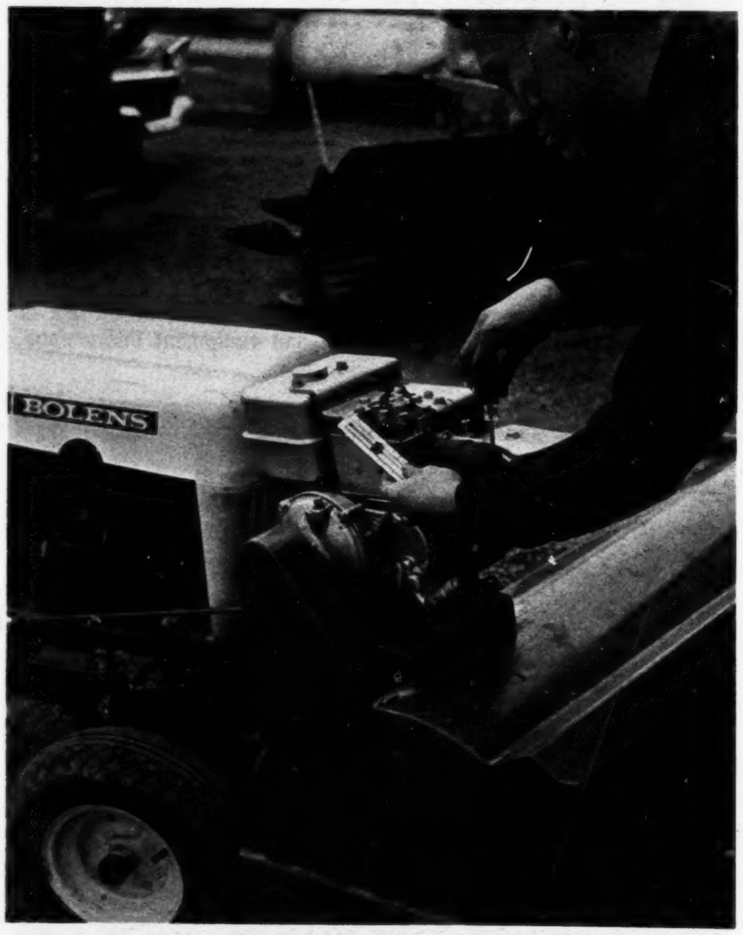


Figure 27.—The engine laboratory must have a variety of testing devices such as this vibration tachometer which is being used to adjust an engine's idling speed.

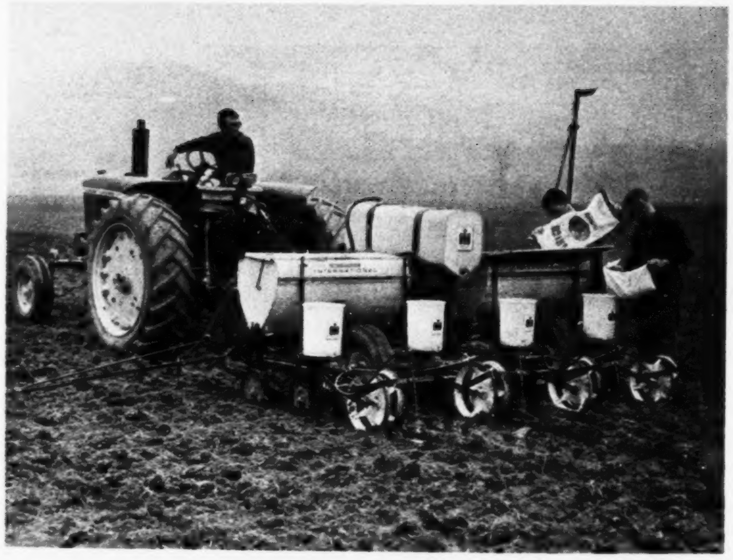


Figure 28.—An example of field equipment operation, using a 4-row corn planter which fertilizes as it plants and applies pre-emergence chemical weed killer all in one operation.

Figure 29.—A student checking operation of equipment after servicing it.

CLASSROOMS

One conventional classroom should be equipped with drawing and drafting equipment, for which figure 30 shows a suggested layout. This drafting room should have lighting equivalent to 75-foot candles at the level of the drawing-table tops. A second classroom large enought to accommodate 65 to 70 students is very desirable. The example shown in figure 31, with a large room and a folding partition in the middle, is satisfactory and flexible in meeting this requirement since two smaller classrooms could be made from it whenever the situation warrants. It is important to separate the classrooms from the laboratory areas by a corridor in order to reduce the noise from the machinery laboratories. (See fig. 6.)

All classroom floors should be covered with materials whose quality and durability are equivalent to that of vinyl flooring. Concrete can be used, but its maintenance is much more costly because of the need for frequent painting or sealing.

All classrooms should be equipped with adequate lighting so that evening classes might be held. Simple, convenient methods of controlling the

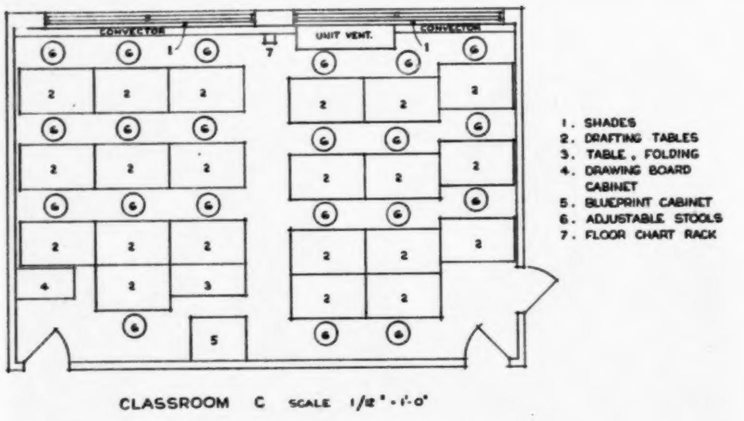

CONVECTOR
UNIT VENT.
CONVECTOR
1. SHADES
2. DRAFTING TABLES
3. TABLE, FOLDING
4. DRAWING BOARD CABINET
5. BLUEPRINT CABINET
6. ADJUSTABLE STOOLS
7. FLOOR CHART RACK
CLASSROOM C SCALE 1/12" = 1'-0"

Figure 30.—An example of a drafting room. (See classroom 22′ by 33′ in figure 6.)

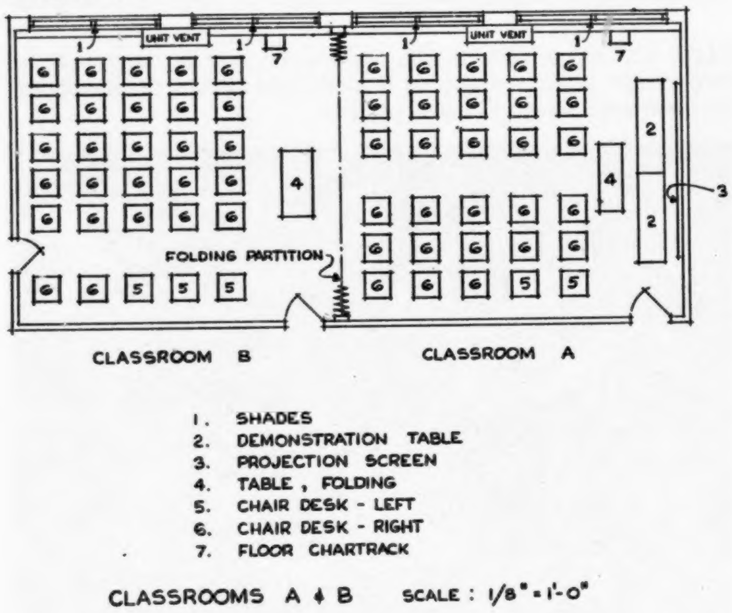

UNIT VENT
UNIT VENT
FOLDING PARTITION
CLASSROOM B
CLASSROOM A
1. SHADES
2. DEMONSTRATION TABLE
3. PROJECTION SCREEN
4. TABLE, FOLDING
5. CHAIR DESK - LEFT
6. CHAIR DESK - RIGHT
7. FLOOR CHARTRACK
CLASSROOMS A & B SCALE: 1/8" = 1'-0"

Figure 31.—An example of a plan for a large classroom which can be divided into two smaller ones by a folding partition. (See figure 6.)

light, including dimmer switches, should be installed so that visual aids may be used efficiently. The use of the overhead projector, as shown in figure 32, is an effective method of presenting diagrams taken from the operators' manuals. The opaque projector in figure 33 is shown being used to illustrate the flow of hydraulic fluid through the hydraulic cylinder shown on the teacher's lectern. Provision should be made for audio equipment and closed circuit television.

The departmental office is located near the main entrance of the building where it is readily accessible. A suggested plan for this office is shown in figure 34. Adequate office space is essential for each faculty member in the agricultural equipment technology building. It is recommended that no more than two staff members be located in any office. Occupation of an office by more than two

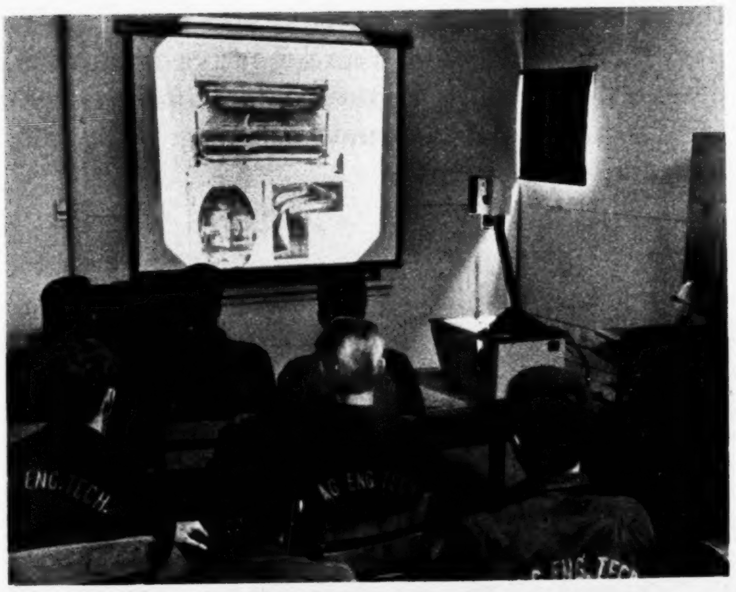


Figure 32.—An overhead projector permits the simultaneous use of specialized materials from parts, books, and equipment instructional manuals by the whole class.

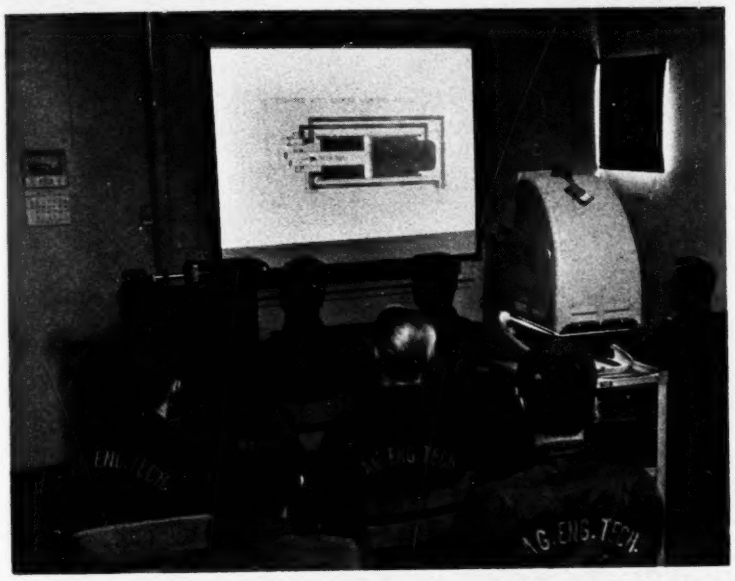


Figure 33.—An opaque projector extends the range of use of available materials beyond that of the overhead projector shown in figure 32.

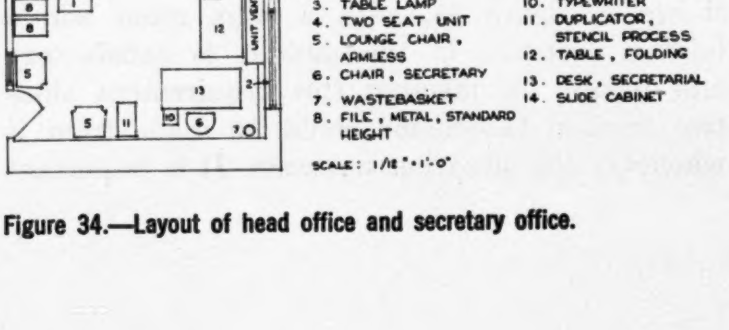

HEAD OFFICE
1. COAT RACK
2. SHADES
3. CHAIR, ADJUSTABLE, EXECUTIVE
4. CHAIR, SIDE W/ARM
5. CHAIR, SIDE, ARMLESS
6. END TABLE
7. WASTEBASKET
8. FILE, METAL, STANDARD HEIGHT
9. MACHINE, DICTATING & TRANSCRIBING
10. DESK, CONFERENCE, ISLAND BASE
11. CREDENZA
12. TABLE, CONFERENCE
SHELVES
KEY CABINET
FIVE SHELVES
UNIT VENT
SECRETARY OFFICE
1. COAT RACK
2. SHADES
3. TABLE LAMP
4. TWO SEAT UNIT
5. LOUNGE CHAIR, ARMLESS
6. CHAIR, SECRETARY
7. WASTEBASKET
8. FILE, METAL, STANDARD HEIGHT
9. CALCULATOR AUTOMATIC PRINT, ELECTRIC
10. TYPEWRITER
11. DUPLICATOR, STENCIL PROCESS
12. TABLE, FOLDING
13. DESK, SECRETARIAL
14. SLIDE CABINET
SCALE: 1/12" = 1'-0"

Figure 34.—Layout of head office and secretary office.

members tends to discourage students from approaching instructors for assistance.

It is desirable to have a waiting room adjacent to staff offices where students can study comfortably while awaiting the instructor's assistance. The waiting room may house the departmental secretary who can arrange conference appointments for students if necessary.

SAFETY

Safety must be a constant preoccupation of both the faculty and the students. Planning for safety can provide essential elements of safe practice at a relatively low cost. Some suggestions are discussed in the following paragraphs.

Each of the laboratories should have at least two exits, preferably at opposite ends of the room. Every room should be equipped with fire extinguishers of the size and type most suitable for the kind of fire most likely to occur in that room. When selecting sizes and types of extinguishers for the various rooms. It is best to obtain the advice of people knowledgeable in fire control in order to insure selection of the proper design and location of the devices within the rooms; and to conform to local fire ordinances.

Even though the paint room may have an adequate exhaust system, all persons who spray paint should be required to wear a respirator designed for use when painting.

Any piece of equipment with moving parts such as gears, wheels, belts, chains, or other moving elements must be protected with safety guards. In situations where visual observation by the operator is necessary (such with a grinding wheel) shatterproof glass must be provided, and illuminated eyeshields are desirable. In circumstances where it is impossible to be completely shielded from potential danger, safety goggles and/or face shields should always be available and must be worn. Using the portable grinder and chipping slag from arc welds are especially hazardous operations. One type of eye protection against the grinding dust from valve-seat reconditioning is shown in figure 35. Suitable filter lenses, goggles or welding hoods must be worn for both oxy-acetylene and arc welding. Protective clothing should be provided for the face, neck, and hands.

Additional safety measures are illustrated in figure 36. The arrows point to check valves inserted in the oxygen and acetylene lines where the supply enters the mixing chamber to keep the oxygen and acetylene mixture from reverse flowing back into the hoses and eventually to the supply tanks where it would cause explosions or fire.

Electrical control panels should be conveniently located and properly identified. Those controlling larger power units should be locked in the "off" position when not being used for instruction.

The welding areas, paint rooms, and rooms in

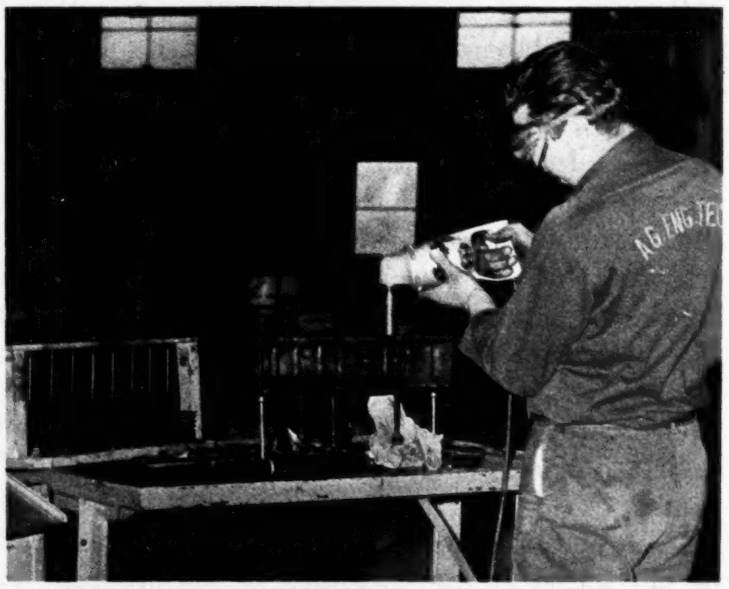


Figure 35.—Safety goggles must be available and worn by anyone performing hazardous operations such as this grinding of engine valve seats.

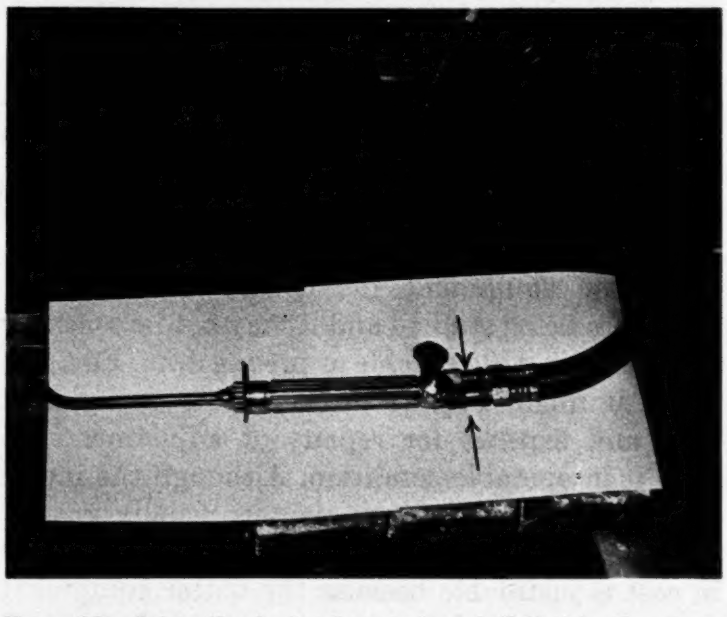


Figure 36.—Automatic check valves such as indicated by the arrows should be required as a safety precaution on oxygen-acetylene welding equipment.

which engines operate must be equipped with adequate exhaust equipment. In the welding areas it is best to remove the fumes at the point of generation. The exhaust devices used in the paint room must be explosion- and sparkproof and separate from the welding exhaust system.

Painted zones around such equipment as power saws and planers should designate work areas for the operator so that other people will stay away from the equipment when it is in use. Warning zones of 2-inch wide lines of yellow paint on the floor around the equipment are recommended.

A nonslip paint or some type of slip-proof mat can be used on the floor near hazardous power machines.

A safety color system such as used in industry should be employed with power equipment.

Equipping the Laboratories and Their Costs

Building and equipping adequate agricultural equipment laboratories is expensive. Ideally, laboratories should be built and completely equipped before the first class of students is enrolled. In practice, however, it is sometimes more feasible to build the laboratories, to install the permanent work stations, lockers, exhaust systems, and to provide only the minimum of laboratory equipment required to begin teaching the program. This allows the program to be initiated with only a minimum outlay of funds and permits the cost of additional necessary or desirable equipment to be spread over a period of years.

If all of the laboratories and equipment cannot be purchased at the beginning of the program, it is strongly recommended that there be no compromise in the quality of those provided. Laboratory equipment and facilities are indispensable if the training objectives are to be met.

Laboratories and equipment for teaching agricultural equipment technology programs must meet high standards of quality since the strength of the instruction lies in providing valid laboratory experiences—basic in nature, broad in variety, and intensive in practical application.

Inferior equipment might not illustrate the principles being studied and it may not be sensitive enough to provide reliable or precise data. Furthermore, it might require unreasonable amounts of time and expense for repairs or adjustments to keep it in operable condition. Although the initial cost of high-quality equipment is usually greater than that of low-quality equipment, the difference in cost is justifiable because the better equipment makes possible laboratory testing that gives precise results.

Well-equipped laboratories with a sufficient variety and number of facilities for all students to perform the laboratory work are therefore required for effective instruction.

The need for each item of laboratory equipment should be clearly established when the staff makes its selection. Expensive devices may not always be required. Many significant demonstrations can be planned around relatively inexpensive components. The number of units purchased in the particular specialized areas, the particular industrial emphasis given, and the ingenuity of the instructor in adapting equipment to teaching needs play major roles in laboratory equipment selection and the funds provided for its purchase. Throughout the program, the emphasis should be on the basic underlying principles which serve as the foundation for so many different tests.

When equipping an agricultural equipment technology program, an important question which must be answered is, "How much farm equipment should be provided?" It is not necessary to have all the latest machinery, and it is not necessary for every student to become proficient with every machine. Some machines can be owned, some can be rented or leased, and some can be obtained on a "demonstration" basis. Machines must be selected for their educational value, rather than as a farmer would, on the basis of need for his particular acreage.

At least one of as many makes of tractor as possible is desirable. It may be well to own as many of the soil engaging tools as possible, since wear and breakage is apt to be greater with these than with other machines. Some of these may be obtained by acquiring and rebuilding used equipment.

Leasing agricultural machinery is good business. Tractors and harvesting equipment are good examples. Some manufacturers have a policy of leasing machines for educational purposes at 10 percent of the purchase price per year. Usually the machine is replaced each year, or at the most, every 2 years. Sometimes a piece of equipment can be leased at a fixed price for 3 years and then owned. For example, a large current model sprayer is made available to one school for a month each spring at a cost of $100. The dealer delivers the machine, and explains and demonstrates it thoroughly. Students then use it on campus trees and shrubs. On rainy days, it is studied in the laboratory.

Agricultural equipment technology instructors and the department head should develop good contacts with dealers of all kinds of farm equipment. Dealers and manufacturers usually will help if they know the need. Faculty members should attend demonstrations, field days, farm auctions, and other affairs to keep up to date. Something new can be learned at each such affair. Keeping in close touch with experiment stations, the State college, research farms, and especially with progressive farmers will help a teaching staff keep up to date and help it decide what equipment must be available for teaching.

The department head or instructor should make final decisions on the choice of laboratory equipment because of his knowledge of technical details. The instructor can avoid costly mistakes which often result if nontechnical personnel attempt to equip a scientific laboratory.

Surplus equipment from private or public organizations can be an important source of good materials and hardware for equipping laboratories. Government surplus property may often be an especially attractive source of either standard or specialized components, units, assemblies, mechanisms, instruments and systems at a cost which usually is only a small fraction of their cost new. Educational institutions are high on the priority list of agencies to which government surplus property is made available.[1]

Distribution of surplus property within the States must be made through State Agencies for Surplus Property. Most such State Agencies maintain one or more distribution centers at which authorized representatives of eligible schools or school systems select materials for educational use. Usually one or more officials of a school or school system are designated as authorized representatives. Technical educators should communicate with their authorized school or school system representative, if one exists, to arrange to visit their State Agency's distribution center, or write to the Director of their State Agency for Surplus Property to obtain information regarding the procedures to be followed in acquiring equipment.

The State Director of Vocational and Technical Education in each State can provide specific information on the location of the government surplus property distributing agency in his State and the persons in charge. Information on government surplus property may also be obtained by writing to:

Chief, Surplus Property Utilization Division
U.S. Department of Health, Education, and Welfare
Washington, D.C. 20201

Experience has shown that it is important to exercise the same elements of judgment and care in acquiring surplus equipment as is used in buying new equipment. Specific plans for the use, and sound justification for the need, should clearly be established for *any* piece of surplus equipment and a careful analysis made of its total effectiveness in the program; its cost including initial cost, transportation, space required, cost of installation, repair or tune-up (if incomplete), and maintenance; and its pertinence in terms of obsolescence.

Only technically competent, responsible, and imaginative persons should select surplus equipment, and then only after a thorough on-site inspection. This practice avoids the temptation or tendency to acquire attractive but obsolete, irrelevant, bulky, or excessive amounts of equipment.

However, granted the foregoing approach, the resourceful department head or instructor can usually obtain quantities of components and materials (often by disassembling units or systems), meters, instruments, apparatus, and other essential up-to-date equipment for agricultural equipment laboratories at a very reasonable cost.

---

[1] U.S. Department of Health, Education, and Welfare. Office of Field Administration. Division of Surplus Property Utilization.

Directory: Directors of State Agencies for Surplus Property and Regional Representatives Division of Surplus Property Utilization, Department of Health, Education, and Welfare. 1965.

How To Acquire Federal Surplus Personal Property for Health, Education, and Civil Defense Purposes and Federal Surplus Real Property for Health and Educational Purposes. 1965.

Surplus Material and Science Education. 1964.

Washington: U.S. Government Printing Office.

The cost estimates which follow assume the availability of a building of suitable construction, equipped with normal services, such as electricity, heat, and water. No provisions are made in these estimates for conventional classroom blackboards, student seats or other classroom equipment, nor for office equipment. It is assumed that a drawing and drafting laboratory is available in the institution.

Neither the conventional firefighting equipment commonly used in school buildings nor the special fire fighting equipment required for an agricultural equipment department is listed, since the type used should conform to local fire ordinances to meet the safety needs of each type of laboratory in the building.

Whenever new or improved equipment or testing devices become available to the agricultural equipment business, new laboratory equipment should be purchased to keep the teaching facilities up to date.

Following are suggestions for equipping the laboratories in the sample floor plans shown on the foregoing pages. In order to provide a guide to the *minimum laboratory equipment and apparatus required* for agricultural equipment technology, the items marked with an asterisk (*) are considered desirable but not absolutely necessary at the beginning of the teaching programs; they should, however, be acquired as the programs progress. If the number of required items is shown with an asterisk, for example, *15 (10) testing benches, this means that 10 testing benches should be acquired at the beginning of the teaching program and an additional 5 added as needed or when financially feasible.

The specifications for laboratory equipment listed in this section are typical for equipment to be used in teaching agricultural equipment technicians and are offered as an assistance to the instructor or department head who is responsible for purchasing the equipment. Quantities suggested are intended for a class of 24 to 30 students, divided into groups of 12 to 15 student laboratory sections for optimum instructional conditions.

When the program has been started and all the recommended equipment has been purchased, it will still be necessary to have an annual equipment and supply budget. These funds are required to replace or repair equipment, restock expendable items, and purchase new equipment to meet regional modifications of the program. At least $3,000 to $5,000 per year should be planned to meet such needs, and substantially more may be required if special new types of equipment are developed and needed to keep the program up to date.

The following lists show the combined estimated gross cost of minimum required and additional equipment needed to adequately equip each laboratory. The Summary of Costs section distinguishes between the costs of items immediately required and the additional items.

Costs estimates for the various lists are given as a range of cost. Individual items are not priced because there may be substantial differences in the cost of comparable equipment and services in various locations.

DIESEL LABORATORY

Quantity	*Item*
*15(10)	Testing benches
*2(1)	Fuel pump calibrating stands, with accessories
1	Injector flow comparator
*8(4)	Diesel engines, various makes and models
*1	Dynamometer
1	Crane, mobile
1	Compression tester, plus adapters
*10(5)	Nozzle and injector service and cleaning kits
1	Fuel injection pump and governor service tool set
4	Nozzle and injector test sets
—	Fuel pumps, nozzles, and injectors, various makes and models

Total estimated cost—$49,000 to $55,000

ELECTRIFICATION LABORATORY

Quantity	*Item*
9	Benches, each with wiring tunnel
18	Adjustable stools
4	Roll cabinets with hand tools
1	Hand truck
1	Hardware cabinet
2	Tool cabinets
7	Storage cabinets
1	Stock cart
1	Motor and generator demonstrator
100	4″ octagonal electric boxes

Quantity	*Item*
100	4″ standard utility boxes
100	4″ lamp sockets
100	Single pole switches
100	Three-way switches
100	Grounded plugs in receptacles
500 ft.	12–2 type UF cables with ground
250 ft.	12–3 type UF cables with ground
100	Box connectors
400	Solderless connectors, various sizes
*20(5)	Electric motors—split phase, capacitor start-induction run, capacitor start-capacitor run, repulsion start-induction run and three phase, sizes ¼ to 1 H.P.
*20(10)	Stop-start push button stations
*20(10)	Magnetic motor starters
*20(10)	Fused switches
*10(5)	Hook-on type AC Volt-Ammeters with voltage range 0–150/300 and amperage range 0–5/15/40/100
1	Master instructor power panel with variable AC and DC current and AC voltmeter, AC ammeter, DC voltmeter, DC ammeter
*4(2)	Soldering guns
*4(2)	Soldering irons
9	Claw hammers
2	Electricians bits ½″
2	Bit braces
2	Allen wrench sets
18	Bar magnets
18	Horseshoe magnets
9	Gilley induction coil sets
18	Small compasses
*18(9)	Electrician tool kits
	Total estimated cost—$8,000 to $10,000

GAS ENGINE AND TRACTOR LABORATORY

Quantity	*Item*
1	Parts washer
1	Gear lubricant dispenser
*2(1)	Lubriguns, high pressure
4	Universal engine stands
15	Combination tool chests and roll cabinets
2	Work benches
*4(1)	Power mechanics benches
1	Jack, portable air-lift
*8(5)	Gasoline engines, various makes and sizes
1	Dynamometer, portable
*20(10)	Small engines, various makes and sizes
1	Rotary mower blade balancer
1	Chainsaw filing tool
—	Special small engine tool sets, as sold by engine manufacturers
*15(8)	Mechanics tool sets
	Total estimated cost—$31,000 to $34,500

HYDRAULICS AND PUMP LABORATORY

Quantity	*Item*
*2(1)	Fluid power trainers
1	Hydraulic training unit
*1	Hydraulic track pin press
15	Student station benches
1	Fluid circuit system
2	Hydraulic system testers
—	Hydraulic hardware, including pumps, valves, cylinders, motors of various makes and sizes
	Total estimated cost—$13,000 to $15,000

MACHINERY LABORATORY

Quantity	*Item*
1	Desk
1	Stool, adjustable leg with backrest
1	Parts washer
1	Steam cleaner
1	Drill press—15″
*2(1)	Grinders—8″
*2(1)	Grinders—10″
1	Disc sander—14″
1	Hydraulic shop press
1	Drill press—21″
15	Work benches
*1	Abrasive blasting machine with reclaimer and dust collector
1	Abrasive blasting machine, mobile
*6(2)	Hydraulic lift tables
1	Crane, portable
1	Chart stand
5	Assorted tool sets with tool boxes
	Total estimated cost—$13,000 to $15,000

PAINT LABORATORY

Quantity	*Item*
2	Paint guns with regulator and moisture trap
*2(1)	Portable paint outfit
1	Exhaust system (fan with explosion-proof motor)
—	Explosion-proof electrical and lighting fixtures
	Total estimated cost—$1,000 to $1,500

PROJECTION AND AUDIOVISUAL AIDS EQUIPMENT

Quantity	*Item*
1	Portable tape recorder
2	Overhead projectors
2	Slide projectors
1	Sound projector, 16 mm.
5	Projection tables
1	Opaque projector
1	Slide camera and copying equipment
2	Wall projection screens
2	Floor projection screens
*1	Closed circuit television
	Total estimated cost—$5,000 to $6,000

TOOL ROOM

Quantity	*Item*
4	Shelving units, steel, bin-type
9	Shelving units, steel
7	Storage cabinets, steel
3	Tool storage cabinets
1	Bin unit, steel
1	Master analyzer
1	Battery charger
1	Wet honing machine
*1	Motor tester
1	Valve-grinding machine
1	Small engine tester
*1	Generator regulator tester
*1	Valve shop
8	Stands, adjustable
1	Jack, transmission-type
1	Portable crane
8	Portable electric drills
1	Plug cleaner
2	Power timing lights
1	Battery service kit
5	Torque wrenches
4	Impact wrenches
2	Extractor sets
1	Spark plug scope
2	Compression testers
—	Micrometers
2	Small-hole gauge sets
1	Spring tension gauge
4	Ridge reamers
*3(1)	Tap and die sets
1	Thread restorer set
1	Axle re-threader
1	Clutch aligner set
1	Bushing remover and inserter set
1	Ford sleeve puller
2	Automotive electricity trainers
2	Dynamometers (drawbar)
2	Retaining ring kits
1	¾'' drive socket set
1	1'' drive socket set
2	Flare-nut wrench sets
1	Brake service tool set
1	Screw starter set
1	Distributor service tool set
1	Wheel seal driver set
1	Oil seal driver set
1	Axle-nut wrench set
4	Ring compressors
1	Camshaft bearing inserter
2	Puller sets
1	Hydraulic puller set
4	Valve service tool sets
—	Miscellaneous tools
1	Connecting rod alignment fixture
1	Dial indicator
1	Cylinder sleeve puller
1	Valve seat insert service tool
2	Cylinder honing tools
1	Tube cutting and flaring tool
	Total estimated cost—$19,500 to $22,000

WELDING LABORATORY

Quantity	*Item*
2	Fire extinguishers, carbon dioxide
—	Welding curtains
8	180-ampere farm-type arc welders of different makes
2	250-ampere AC arc welders of different makes

Quantity	*Item*
2	300-ampere AC–DC rectifier-type arc welder with inert gas attachments
*2(1)	Spot welding guns
*2(1)	Grinders—10″
*1	Grinder—8″
12	2′ x 2′ arc welding benches (home-made)
2	Guided bend testers
1	Universal testing machine, 60,000-lb. capacity
6	Oxy-acetylene benches with regulators, hoses, and torches
2	Heavy-duty 5″ vises
18	Weld cleaning tools
18	Blacksmith tongs
2	Sledge hammers

Quantity	*Item*
1	Hydraulic cutting shear for bars, rounds and angles
1	Power hacksaw
18 pr.	Welders gloves
—	Helmets, face shields, safety glasses
1	Magna-flux testing unit
1	Demonstration screen
1	Drill press, 17″
*1	Optical comparator
1	Metal and scrap rack
1	Stock cart
5	Work benches
2	Storage cabinets
1	Steel shelving unit
*1	Gas forge
	Total estimated cost—$13,500 to $15,000

Summary of Costs

The equipment listed above is basic and does not include items for specialized programs. The cost estimates are based on the assumption that new equipment of good quality will be purchased in the quantities indicated. Especially advantageous buying, acquisition of suitable government or private surplus equipment, or unusually ingenious use of components built into teaching systems by the instructional staff may make it possible to equip laboratories for less cost; however, this is not always the case.

Therefore, the total cost of equipping an agricultural equipment technology program, based on prices in 1967, may be estimated as follows:

Facility	*Estimated cost*
Diesel Laboratory	
Minimum required equipment	$25, 500 to $28, 500
*Additional to fully equip laboratory	23, 500 to 26, 500
Electrification Laboratory	
Minimum required equipment	7, 000 to 8, 500
*Additional to fully equip laboratory	1, 000 to 1, 500
Gas Engines and Tractor Laboratory	
Minimum required equipment	20, 000 to 22, 000
*Additional to fully equip laboratory	11, 000 to 12, 500
Hydraulic and Pump Laboratory	
Minimum required equipment	10, 000 to 11, 500
*Additional to fully equip laboratory	$3, 000 to $3, 500
Machinery Laboratory	
Minimum required equipment	9, 500 to 11, 000
*Additional to fully equip laboratory	3, 500 to 4, 000
Paint Laboratory	
Minimum required equipment	750 to 1, 000
*Additional to fully equip laboratory	250 to 500
Projection and Audio-Visual Aids Equipment	
Minimum required equipment	2, 000 to 2, 500
*Additional to fully equip facility	3, 000 to 3, 500
Tool Room	
Minimum required equipment	15, 500 to 17, 000
*Additional to fully equip laboratory	4, 000 to 4, 500
Welding Laboratory	
Minimum required equipment	12, 000 to 13, 000
*Additional to fully equip laboratory	1, 500 to 2, 000
Suggested Fund for Leasing Equipment	1, 500 to 2, 500
Work Benches, Fixtures, and Storage Cabinets, Installed	2, 500 to 4, 000
Total estimated cost to fully equip the program	157, 000 to 180, 000

The total estimated cost of $157,000 to $180,000 to fully equip an agricultural equipment technology program may, if necessary, be reduced to the total cost of the minimum recommended equipment by deferring the purchase of the items marked (*) (totalling $50,750 to $58,500) until their purchase is financially feasible. Thus, the estimated cost of the minimum recommended equipment and facilities to undertake a program is from $106,250 to $121,500.

---

*Total estimated cost of items which can be deferred temporarily, $50,750 to $58,500.

The foregoing estimates do not provide for the cost of a farm nor the building, which, if constructed for the program, may be calculated at $14 to $16 per square foot of unfurnished laboratory space. Such space with special utilities and built-in furnishings, but without portable equipment, may be estimated at $25 to $30 per square foot.

BIBLIOGRAPHY

Note: All items with dates are first editions. All publications which have gone through one or more revisions or which are subject to frequent revision (i.e., handbooks, manufacturer's operator's manuals) are marked "current edition," in order to help those who may order them to order the most recently published information.

Books and Handbooks

AC Spark Plug, Oscilloscope and Tune-Up Manual. Flint, Mich.: AC Spark Plug Division, General Motors Corp., current edition.

Ace Pumps. Memphis, Tenn.: Ace Pump Corp., current edition.

Aeroquip Basic Hydraulics Program. Bulletin No. 632. Jackson, Mich.: Aeroquip Corp., 1964.

Agricultural Spray Nozzle Manual. Bellwood, Ill.: Spraying Systems Co., current edition.

Agricultural Spray Nozzle Manual, Industrial Spray Nozzles and Related Equipment. Bellwood, Ill.: Spraying Systems Co., current edition.

Annual Farm Equipment Red Book. Kansas City, Mo.: Implement & Tractor Publications, Inc., current edition.

Armstrong, L. V. *and* Hartman, J. B. *The Diesel Engine.* New York: Macmillan Co., 1959.

ASA Graphical Symbols and Diagrams. New York: American Standards Association, current edition.

ASAE Yearbook. St. Joseph, Mich.: American Society of Agricultural Engineers, current edition.

Audel's Diesel Engine Manual. New York: Theo. Audel & Co., 1960.

Aurner, Robert R. *Effective Communication in Business.* New Rochelle, N.Y.: South-Western Publishing Co., current edition.

Automotive Diesel Engines. Engineering Bulletin AD206. Chicago: Standard Oil Co., current edition.

Bainer, Roy *and others. Principles of Farm Machinery.* New York: John Wiley & Sons, Inc., 1955.

Ball and Roller Bearings. Chicago: International Harvester Co., 1964.

Barger, E. L. *and others. Tractors and Their Power Units.* New York: John Wiley & Sons, Inc., current edition.

Basic Ball Bearing Types. Bristol, Conn.: New Departure Division, General Motors Corp., current edition.

Basic Hydraulics. Racine, Wis.: Racine Hydraulics & Machinery Co., current edition.

Beardsley, Monroe C. *Thinking Straight.* Englewood Cliffs, N.J.: Prentice-Hall, Inc., current edition.

Bearing Failure Identification. Bristol, Conn.: New Departure Division, General Motors Corp., current edition.

Beiser, Arthur. *Modern Technical Physics.* Reading, Mass.: Addison-Wesley, 1966.

Bennett, Millard. *The Power of Inspired Salesmanship.* New York: Frederick Fell, Inc., 1960.

Benumof, Reuben. *Concepts in Physics.* Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1965.

Berlo, David K. *The Process of Communication.* New York: Holt, Rinehart & Winston, 1960.

Berton, Pierre. *The Big Sell.* New York: Alfred A. Knopf, 1963.

Better Ignition. DR-5141. Anderson, Ind.: Delco-Remy Division, General Motors Corp., current edition.

Bierstedt, Robert. *The Social Order.* New York: McGraw-Hill Book Co., Inc., current edition.

Bierstedt, Robert *and others. Modern Social Science.* New York: McGraw-Hill Book Co., Inc., 1964.

Biesanz, John B. *and* Biesanz, Mavis. *Modern Society.* Englewood Cliffs, N.J.: Prentice-Hall, Inc., current edition.

Blodgett, Omer W. *Design of Weldments.* Cleveland: The James F. Lincoln Arc Welding Foundation, 1963.

Blumenthal, Lassor A. *Great Sales by Today's Great Salesmen.* New York: Macmillan Co., 1965.

Boyd, Maurice *and* Worcester, D. E. *American Civilization.* Rockleigh, N.J.: College Division, Allyn & Bacon, Inc., 1964.

Brown, Arlen D. *and* Morrison, Ivan G. *Farm Tractor Maintenance.* Danville, Ill.: Interstate Printers & Publishers, Inc., current edition.

Brown, James. *Casebook for Technical Writers.* Belmont, Calif.: Wadsworth Publishing Co., Inc., 1961.

Brown, Roger. *Words and Things.* Glencoe, Ill.: The Free Press, 1958.

Calhoon, Richard P. *Managing Personnel.* New York: Harper & Row, Publishers, 1963.

Campbell, James *and* Helpler, Hal. W. *Dimensions in Communication.* Belmont, Calif.: Wadsworth Publishing Co., Inc., 1965.

Canfield, Bertrand R. *Salesmanship Practices and Problems.* New York: McGraw-Hill Book Co., Inc., 1958.

Carson, Alexander B. *and others. College Accounting.* Cincinnati: South-Western Publishing Co., current edition.

Case, Keith *and* Vardaman, George. *Mature Reading and Thinking*. Minneapolis: Burgess Publishing Co., 1959.

Chemical Applicators. Owatonna, Minn.: Gandy Co., current edition.

Chinoy, Ely S. *Society: An Introduction to Sociology*. New York: Random House, Inc., 1961.

Chruden, Herbert J. *and* Sherman, Arthur W. *Personnel Management*. New Rochelle, N.Y.: South-Western Publishing Co., current edition.

Clayton, J. T. *and others*. *Farmstead Engineering for Dairy Farms*. Bulletin 351. Amherst, Mass.: University of Massachusetts, 1960.

Corbin, Richard K. *and* Perrin, Porter G. *Guide to Modern English*. Chicago: Scott, Foresman & Co., 1962.

Coser, Lewis A. *Sociology Through Literature*. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1963.

The Cranking Circuit. DR–9025. Anderson, Ind.: Delco-Remy Division, General Motors Corp., current edition.

Crispin, T. S. *Dictionary of Technical Terms*. Milwaukee: The Bruce Publishing Co., current edition.

Crouch, W. George *and* Zetler, Robert. *A Guide to Technical Writing*. New York: Ronald Press, current edition.

Crouse, William H. *Automotive Mechanics*. New York: McGraw-Hill Book Co., Inc., current edition.

Dance, Frank E. X. *Human Communication Theory: A Book of Readings*. New York: Holt, Rinehart & Winston, 1966.

Davis, Hollis R. *and* Furry, Ronald B. *Bulk Bins for Dairy Feed*. Bulletin No. 350. Ithaca, N.Y.: Department of Agricultural Engineering, Cornell University, 1958.

Davis, Keith. *Human Relations at Work*. New York: McGraw-Hill Book Co., Inc., current edition.

______. *Human Relations in Business*. New York: McGraw-Hill Book Co., Inc., 1957.

Davis, Keith *and* Scott, William G. *Readings in Human Relations*. New York: McGraw-Hill Book Co., Inc., 1959.

Dean, Howard *and* Bryson, Kenneth D. *Effective Communication*. Englewood Cliffs, N.J.: Prentice-Hall, Inc., current edition.

Delavan Agricultural Spray Equipment. West Des Moines, Iowa: Delavan Manufacturing Co., current edition.

Delco Moraine Brake Service Manual. Dayton, Ohio: Delco Moraine Division, General Motors Corp., current edition.

Delco Moraine Power Brake Service Manual. Dayton, Ohio Delco Moraine Division, General Motors Corp., current edition.

Delco-Remy Maintenance Handbooks. DR–324—1, 2, 3, 4. Anderson, Ind.: Delco-Remy Division, General Motors Corp., current edition.

Delco-Remy Test Specifications. DR–324S, S–1, S–2. Anderson, Ind.: Delco-Remy Division, General Motors Corp., current edition.

Design, Operation, and Maintenance of Hydraulic Equipment for Use With Fire Resistant Fluids. Thiensville, Wis.: National Fluid Power Association, current edition.

Diesel—The Modern Power. Warren, Mich.: Educational Relations Section, General Motors Corp., current edition.

Dimension Identification Code for Fluid Power Cylinders. Thiensville, Wis.: National Fluid Power Association, current edition.

Doctor of Motors: Rx for Better Gasoline Engine Overhauls. Hagerstown, Ind.: Technical Service Department, Dana Parts Co., 1965.

Doctor of Motors: Rx for Preventing Oil Loss Through Valve Guides. Hagerstown, Ind.: Technical Service Department, Dana Parts Co., 1963.

Donaldson, Elvin F. *and* Pfahl, John K. *Personal Finance*. New York: Ronald Press, current edition.

Douglass, Paul. *Communication Through Reports*. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1957.

Duffy, Joseph W. *Power, Prime Mover of Technology*. Bloomington, Ill.: McKnight and McKnight, 1964.

Eisenson, Jon *and others*. *The Psychology of Communication*. New York: Appleton-Century-Crofts, 1963.

Electrical Terms. Athens, Ga.: American Association for Agricultural Engineering and Vocational Agriculture, 1962.

Engine Installation Manual. Chicago: Internal Combustion Engine Institute, 1962.

Erving, Charles G. *Small Engines and Chain Saws Flat Rate Pricing Guide*. Kansas City, Mo.: Technical Publications, Inc., current edition.

Estrin, Herman A. *Technical and Professional Writing: A Practical Anthology*. New York: Harcourt, Brace & World, Inc., 1963.

Evans, Bergan *and* Evans, Cornelia. *A Dictionary of Contemporary American Usage*. New York: Random House, Inc., 1957.

Facts About Storage Batteries. Bulletin. Cleveland: EBS Brands, Inc., 1964.

Farm Chemicals Handbook. Willoughby, Ohio: Meister Publishing Co., 1966.

Farm Electric Motors—Selection, Protection and Drives. Athens, Ga.: American Association for Agricultural Engineering and Vocational Agriculture, 1964.

Farm Electric Sales Handbook. New York: Edison Electric Institute, current edition.

Farm Electrification. New York: Edison Electric Institute, current edition.

Farm Tractors. Engineering Bulletin FT–53. Chicago: American Oil Co., 1963.

Farmstead Modernization—Key to Increased Profits. Bulletin. Columbus, Nebr.: Educational Service, Behlen Manufacturing Co., current edition.

Farmstead Wiring Handbook. New York: Edison Electric Institute, 1965. Fenske, Theodore H. *and others*. *Arithmetic in Agriculture*. Danville, Ill.: Interstate Printers & Publishers, Inc., 1951.

Fleming, Joseph W. *and others*. *Applied Drawing and Sketching*. Chicago: American Technical Society, current edition.

Flippo, Edwin B. *Principles of Personnel Management.* New York: McGraw-Hill Book Co., Inc., current edition.

Fluid Motors. New York: American Society of Mechanical Engineers, 1959.

Fluid Power Handbook and Directory. Cleveland: Industrial Publishing Corp., current edition.

Fluids and Seals. Pewaukee, Wis.: The Dynex Co., current edition.

Fowler, Henry W. *A Dictionary of Modern English Usage.* New York: Oxford University Press, 1959.

Fox, Gerald B. *Diesel Operation and Fault Diagnosis.* New York: Macmillan Co., 1955.

Frazee, Irving *and* Bedell, Earl. *Automotive Electrical Systems.* Chicago: American Technical Society, current edition.

———. *Automotive Fuel and Ignition Systems.* Chicago: American Technical Society, 1960.

Frazee, Irving *and* Eshelman, Philip. *Tractors and Crawlers.* Chicago: American Technical Society, 1957.

Frazee, Irving *and others. Automotive Brakes and Power Transmission Systems.* Chicago: American Technical Society, 1964.

French, Thomas E. *Engineering Drawing.* New York: McGraw-Hill Book Co., Inc., current edition.

Fries, Charles C. *The Structure of English.* New York: Harcourt, Brace & World, Inc., 1952.

Fuel Oil and High RPM Diesel Engines. Detroit, Mich.: Detroit Diesel Engine Division, current edition.

Gambs, John S. *and* Komisar, Jerome B. *Economics and Man.* Homewood, Ill.: Richard D. Irwin, Inc., 1964.

Gardner, Burleigh B. *and* Moore, David G. *Human Relations in Industry.* Homewood, Ill.: Richard D. Irwin, Inc., current edition.

General Theories of Operation. Milwaukee: Briggs & Stratton Corp., current edition.

Giachino, J. W. *and* Beukema, Henry J. *Freehand Sketching.* Chicago: American Technical Society, 1955.

Giachino, J. W. *and others. Welding Skills and Practices.* Chicago: American Technical Society, 1965.

Gibbons, L. L. *and* Moody, L. L. *Power Mechanics.* Dubuque, Ia.: William C. Brown Book Co., 1964.

Giesecke, Frederick E. *and others. Technical Drawing.* New York: Macmillan Co., current edition.

Glenn, Harold T. *Glenn's Auto Repair Manual.* Philadelphia: Chilton Co., 1966.

Glossary of Terms for Fluid Power. Thiensville, Wis.: National Fluid Power Association, current edition.

Graham, Frank D. *Audel's Pumps, Hydraulics, Air Compressors.* New York: Theo. Audel & Co., 1960.

———. *Audel's Truck and Tractor Guide.* New York: Theo. Audel & Co., 1960.

Grain Drying Manual. New York: Edison Electric Institute, current edition.

Greenwood, Douglas. *Mechanical Power Transmission.* New York: McGraw-Hill Book Co., Inc., 1962.

Greif, Edwin Charles. *Modern Salesmanship.* Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1958.

Griffen, Ivan *and* Roden, Edward M. *Basic Arc Welding.* Albany, N.Y.: Delmar Publishers, Inc., 1960.

Grossack, Martin M. *Understanding Consumer Behavior.* Boston: The Christopher Publishing House, 1965.

Grounds Equipment Trade-In Guide. Kansas City, Mo.: Technical Publications, Inc., 1966.

Guest, R. W. *Feed Ration Processing for Dairy, Poultry, and Other Livestock.* Ithaca, N.Y.: Department of Agricultural Engineering, Cornell University, 1965. (Mimeographed)

———. *Mechanical Equipment for Handling and Feeding Forage.* Bulletin No. 348. Ithaca, N.Y.: Cornell University, 1961.

Guest, R. W. *and* Spencer, J. W. *Milking Machine System.* Bulletin No. 64. Ithaca, N.Y.: Department of Agricultural Engineering, Cornell University, 1965.

Gulvin, H. E. *and* Stone, A. A. *Machines for Power Farming.* New York: John Wiley & Sons, Inc., 1957.

Haas, Kenneth B. *Professional Salesmanship.* New York: Holt, Rinehart & Winston, 1962.

Hall, C. W. *Processing Equipment for Agricultural Products.* Ann Arbor, Mich.: Edwards Bros., Inc., 1963.

Hamilton, J. Roland. *Using Electricity on the Farm.* Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1959.

Haney, William V. *Communication: Patterns and Incidents.* Homewood, Ill.: Richard D. Irwin, Inc., 1960.

Hattwick, Melvin S. *The New Psychology of Selling.* New York: McGraw-Hill Book Co., Inc., 1960.

Hay Conditioners. Bulletin No. 339. Ithaca, N.Y.: Cornell University, 1961.

Hay Conditioners in the Northeastern United States. Bulletin No. 449. Ithaca, N.Y.: Cornell University, 1960.

Hays, Robert. *Principles of Technical Writing.* Reading, Mass.: Addison-Wesley Publishing Co., Inc., 1965.

Heavy Duty Generator Regulators. DR-5170, DR-5190. Anderson, Ind.: Delco-Remy Division, General Motors Corp., current edition.

Heckman, I. L. *and* Huneryager, S. C. *Human Relations in Management.* New Rochelle, N.Y.: South-Western Publishing Co., 1960.

Heinton, Truman *and others. Electricity in Agricultural Engineering.* New York: John Wiley & Sons, Inc., 1958.

Heldt, P. M. *High Speed Combustion Engines.* Philadelphia: Chilton Co., current edition.

———. *High-Speed Diesel Engines.* Philadelphia: Chilton Co., 1953.

———. *Torque Converters or Transmissions.* Philadelphia: Chilton Co., 1955.

Henderson, G. E. *Planning Water Systems for Farm and Home.* Athens, Ga.: American Association for Agricultural Engineering & Vocational Agriculture, 1963.

Henke, Russell W. *Closing the Loop.* Cleveland: Huebner Publications, Inc., current edition.

Home and Farm Water Supply Manual. Ashland, Ohio: F. E. Myers & Bros. Co., 1963.

The How and Why of Automotive Tune-Up Service. Chicago: The Check-Chart Corp., 1962.

The How and Why of Tire, Battery and Accessory Service. Chicago: The Check-Chart Corp., 1962.

HULL, D. O. *Farm Feed Processing with Portable Grinder Mixers.* West Bend, Wis.: Gehl Bros. Manufacturing Co., 1964.

Human Relations in Agricultural Occupations. Agdex 903/017. Columbus, Ohio: Ohio State University, 1965.

HUNDTOFT, E. B. *and* GUEST, R. W. *Handling Hay Crops.* Series of four Bulletins—Nos. 363, 364, 365, 366. Ithaca, N.Y.: Department of Agricultural Engineering, Cornell University, 1965.

HUNT, DONNELL. *Farm Power and Machinery Management.* Ames, Iowa: Iowa State University Press, current edition.

HUNT, E. F. *Social Science: An Introduction to the Study of Society.* New York: Macmillan Co., current edition.

Hydraulic Machinery. New York: Texaco, Inc., current edition.

Hydraulic Power Transmission. HP–210. Chicago: Standard Oil Co., current edition.

Hydraulic Theory. Racine, Wis.: J. I. Case Co., current edition.

Hydraulics. GSS1277. Chicago: International Harvester Co., current edition.

I & T Shop Service. Kansas City, Mo.: Technical Publications, Inc., 1966.

Implement and Tractor Flat Rate Manuals. Kansas City, Mo.: Implement & Tractor Publications, Inc., current edition.

Implement and Tractor Service Manuals. Kansas City, Mo.: Implement & Tractor Publications, Inc., current edition.

Industrial Hydraulics Manual. 935100. Troy, Mich.: Vickers, Inc., 1962.

Instructional Manual for FER 500A Bookkeeping System (FER 501). St. Louis: National Retail Farm Equipment Association, 1960.

Introducing the Delcotron Generator and the Charging Circuit. DR–9011. Anderson, Ind.: Delco-Remy Division, General Motors Corp., current edition.

An Introduction to the Automotive Electrical System. DR–9010. Anderson, Ind.: Delco-Remy Division, General Motors Corp., current edition.

It's Easy To Be an Expert . . . Battery Man, That Is. DR–9018. Anderson, Ind.: Delco-Remy Division, General Motors Corp., current edition.

JIC Hydraulic Standards. Cleveland: Industrial Publishing Corp., current edition.

JEFFERSON, T. B. *Welding Encyclopedia.* Morton Grove, Ill.: Welding Engineer Publications, current edition.

JEFFERSON, T. B. *and* WOODS, GORHAM. *Metals and How To Weld Them.* Cleveland: The James F. Lincoln Arc Welding Foundation, current edition.

JONES, FRED R. *Farm Gas Engines and Tractors.* New York: McGraw-Hill Book Co., Inc., current edition.

JOSEPH, ALEXANDER *and others. Physics for Engineering Technology.* New York: John Wiley & Sons, Inc., 1966.

JUCIUS, MICHAEL J. *Personnel Management.* Homewood, Ill.: Richard D. Irwin, Inc., current edition.

JUDGE, ARTHUR W. *High Speed Diesel Engines.* Princeton, N.J.: D. Van Nostrand Co., Inc., 1957.

KAPP, REGINALD O. *The Presentation of Technical Information.* New York: Macmillan Co., 1957.

KATES, EDGAR J. *Diesel and High-Compression Gas Engines.* Chicago: American Technical Society, 1965.

KEILY, HELEN J. *and* WALTERS, R. G. *How To Find and Apply for a Job.* New Rochelle, N.Y.: South-Western Publishing Co., current edition.

KIRKPATRICK, CHARLES A. *Salesmanship.* New Rochelle, N.Y.: South-Western Publishing Co., 1966.

KITTS, HARRY W. *and* NABBEN, MARVIN. *Farm Electricity.* Albany, N.Y.: Delmar Publishers, Inc., 1960.

KLINGMAN, GLENN C. *Weed Control as a Science.* New York: John Wiley & Sons, Inc., 1961.

KUGLER, HAROLD L. *Arc Welding Lessons for School and Farm Shop.* Cleveland: The James F. Lincoln Arc Welding Foundation, 1957.

LEWIS, ERNEST E. *and* STERN, Hansjoerg. *Design of Hydraulic Control Systems.* New York: McGraw-Hill Book Co., Inc., 1962.

LONG, KENNETH F. *Chain Saw Service Manual.* Kansas City, Mo.: Technical Publications, Inc., 1964.

———. *Small Engines Service Manual.* Kansas City, Mo.: Technical Publications, Inc., 1964.

———. *Small Tractor Service Manual.* Kansas City, Mo.: Technical Publications, Inc., 1965.

LUZADDER, WARREN J. *and* HORNUNG, WILLIAM J. *Technical Drafting Essentials.* Englewood Cliffs, N.J.: Prentice-Hall, Inc., current edition.

LYN, ROBERT A. *Basic Economic Principles.* New York: McGraw-Hill Book Co., Inc., 1965.

LYTEL, ALAN. *ABC's of Electric Motors and Generators.* Indianapolis, Ind.: Howard W. Sams & Co., 1964.

MACDONALD, JOHN A. *Strategies That Close Sales.* Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1959.

MACKIN, FRANK L. *Hydraulic Controls on Machine Tools.* Flint, Mich.: Frank L. Mackin, 2118 E. Court St., current edition.

Maintaining the Farm Wiring and Lighting System. Athens, Ga.: American Association for Agricultural Engineering and Vocational Agriculture, 1965.

MALEEV, V. L. *Diesel Engine Operation and Maintenance.* New York: McGraw-Hill Book Co., Inc., 1954.

MANTELL, CHARLES L. *Engineering Materials Handbook.* New York: McGraw-Hill Book Co., Inc., 1958.

Master Service Manual. Grafton, Wis.: Tecumseh Products Co., current edition.

MCCORMICK, W. Wallace. *Fundamentals of College Physics.* New York: Macmillan Co., 1965.

MCCRIMMON, JAMES M. *Writing with a Purpose.* Boston: Houghton Mifflin Co., current edition.

MCGREGOR, DOUGLAS. *The Human Side of Enterprise.* New York: McGraw-Hill Book Co., Inc., 1960.

MCNEIL, IAN. *Hydraulic Operation and Control of Machines.* New York: Ronald Press, 1955.

———. *Trouble Free Hydraulics.* New York: Ronald Press, 1958.

MCNICKLE, L. S. *Simplified Hydraulics.* New York: McGraw-Hill Book Co., Inc., 1966.

MEAD, EUGENE *and* MEAD, FRANCHON. *Man Among Men: An Introduction to Sociology.* Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1965.

MEIGS, WALTER B. *and* JOHNSON, CHARLES E. *Accounting.* New York: McGraw-Hill Book Co., Inc., 1962.

MENZEL, DONALD H. *and others. Writing a Technical Paper.* New York: McGraw-Hill Book Co., Inc., 1961.

MERRILL, FRANCIS E. *Society and Culture: An Introduction to Sociology.* Englewood Cliffs, N.J.: Prentice-Hall, Inc., current edition.

METCALF, R. L. *and others. Destructive and Useful Insects.* New York: McGraw-Hill Book Co., Inc., 1962.

MILLER, FRANKLIN. *College Physics.* New York: Harcourt, Brace and World, Inc., 1959.

Mitchell, JOHN. *Handbook of Technical Communication.* Belmont, Calif.: Wadsworth Publishing Co., Inc., 1962.

Moldboard Plows. Bulletin 2172. Washington, D.C.: U.S. Department of Agriculture, 1961.

MOLLOY, E. *Diesel Engine Manual.* London, England: George Newnes Ltd., 1959.

Monarch Farm Spray Equipment. Monarch Industrial Spray Nozzles and Accessories. Philadelphia, Pa.: Monarch Manufacturing Works, Inc., current edition.

MORFORD, V. J. *Farm Arc Welding.* Cleveland: The James F. Lincoln Arc Welding Foundation, 1954.

Motor's Truck Repair Manual. New York: Motor, current edition.

MOTT, PAUL E. *The Organization of Society*, Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1965.

National Electric Code. New York: National Board of Fire Underwriters, current edition.

New Departure Ball Bearings for Farm Implements. Bristol, Conn.: New Departure Division, General Motors Corp., current edition.

NICHOLSON, MARGARET. *A Dictionary of American-English Usage.* New York: Signet, The New American Library, 1958.

NISWONGER, C. ROLLIN *and* FESS, PHILIP E. *Accounting Principles.* Cincinnati: South-Western Publishing Co., current edition.

Noble Chemical Applicators. Sac City, Iowa.: Noble Manufacturing Co., current edition.

O'BRIEN, R. W. *and others. Readings in General Sociology.* Boston: Houghton Mifflin Co., current edition.

ODIORNE, GEORGE S. *Personnel Policy: Issues and Practices.* Columbus, Ohio: C. E. Merrill Books, 1963.

OGBURN, WILLIAM F. *and* NIMKOFF, MEYER F. *Sociology.* Boston: Houghton Mifflin Co., current edition.

OLIVO, C. THOMAS. *Basic Mathematics Simplified.* Volumes I and II. Albany, N.Y.: Delmar Publishers, Inc., 1953.

OLIVO, C. THOMAS *and* PAYNE, ALBERT V. *Basic Blueprint Reading and Sketching.* Albany, N.Y.: Delmar Publishers, Inc., 1952.

Operation and Care of Hydraulic Machinery. New York: The Texas Co., 1954.

The Oxy-Acetylene Handbook. New York: Union Carbide Corp. 1960.

PARKER, MARVIN M. *Farm Welding.* New York: McGraw-Hill Book Co., Inc., 1958.

Parts Manuals. Available from manufacturers.

PEDERSEN, CARLTON A. *and* WRIGHT, MILBURN D. *Salesmanship, Principles and Methods.* Homewood, Ill.: Richard D. Irwin, Inc., 1966.

Periodic Maintenance and Circuit Checks. DR-5221. Anderson, Ind.: Delco-Remy Division, General Motors Corp., current edition.

PERRY, G. C. *Mow Hay Driers.* Bulletin 1008, Revised. Ithaca, N.Y.: Cornell Unitersity, 1962.

Personnel Management, Policies and Practices. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1965. (Loose-leaf reference book for use in the library only)

PFIFFNER, JOHN M. *The Supervision of Personnel; Human Relations in the Management of Men.* Englewood Cliffs, N.J.: Prentice-Hall, Inc., current edition.

PIPPENGER, J. J. *and* HICKS, T. G. *Industrial Hydraulics.* New York: McGraw-Hill Book Co., Inc., 1962.

PIPPENGER, J. J. *and* KOFF, R. M. *Fluid Power Controls.* New York: McGraw-Hill Book Co., Inc., 1959.

Power Goes to Work. Warren, Mich.: Public Relations Staff, General Motors Corp., current edition.

Practical Problems in Mathematics, Automotive Trades. Albany, N.Y.: Delmar Publishers, Inc., current edition.

Procedure Handbook of Arc Welding Design and Practice. Cleveland: The Lincoln Electric Co., current edition.

PROMSBERGER, WILLIAM J. *and* BISHOP, FRANK E. *Modern Farm Power.* Englewood Cliffs. N.J.: Prentice-Hall, Inc., 1962.

PUCKETT, H. B. *Automatic Feeding Equipment for Livestock and Poultry.* Bulletin No. 2198. Washington, D.C.: U.S. Government Printing Office, 1964.

PURVIS, JUD. *All About Small Gas Engines.* Chicago: Goodheart-Willcox, 1960.

RAUX, EMILLE. *Salesman's New Complete Ideas Handbook.* Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1961.

REDDING, W. CHARLES *and* SANBORN, GEORGE A. *Business and Industrial Communication.* New York: Harper & Row, Publishers, 1964.

Regulation and the Charging Circuit. DR-9015. Anderson, Ind.: Delco-Remy Division, General Motors Corp., current edition.

REHKUGLER, G. E. *and* MILLIER, W. F. *Performance of Auger Conveyors for Handling Grain and Ground Feeds.* Bulletin No. 325. Ithaca, N.Y.: Department of Agricultural Engineering, Cornell University, 1959.

RICHTER, H. P. *Practical Electrical Wiring.* New York: McGraw-Hill Book Co., Inc., 1960.

ROBERTS, PAUL. *Understanding English.* New York: Harper & Row, Publishers, 1958.

ROSENBERG, R. ROBERT. *Business Mathematics.* New York: McGraw-Hill Book Co., Inc., current edition.

ROSS, RALPH C. *and* VAN DEN HAAG, ERNEST. *The Fabric of Society.* New York: Harcourt, Brace and World, Inc., 1957.

ROTH, CHARLES B. *How To Find and Qualify Prospects and Get Interviews.* Englewood Cliffs, N.J.: Prentice-Hall., Inc., 1960.

ROUSE, HUNTER *and* INCE, SIMON. *History of Hydraulics.* Iowa City, Iowa: State University of Iowa, Iowa Institute of Hydraulic Research, 1957.

Sales Service Manual. Maquoketa, Iowa: Clinton Engines Corp., current edition.

SAUNDERS, FREDERICK A. *and* KIRKPATRICK, PAUL. *College Physics.* New York: Holt, Rinehart and Winston, current edition.

SCHMID, CALVIN. *Handbook of Graphic Presentation.* New York: Ronald Press, 1954.

SCHUTTE, W. M. *and* STEINBERG, ERWIN R. *Communication in Business and Industry.* New York: Holt, Rinehart and Winston, 1960.

SCOTT, WALTER D. *and others. Personnel Management: Principles, Practices, and Point of View.* New York: McGraw-Hill Book Co., Inc., current edition.

Seals, Separators, Lubricants. Bristol, Conn.: New Departure Division, General Motors Corp., current edition.

The Self-Propelled Windrower. Bulletin No. 358. Ithaca, N.Y.: Cornell University, 1964.

SEMAT, HENRY. *Fundamentals of Physics.* New York: Holt, Rinehart and Winston, current edition.

Service Center Management Manual. Chicago: International Harvester Co., current edition.

Service and Installation Manual. Toledo: Champion Spark Plug Co., 1958.

Service Manual for the Doctor of Motors. Hagerstown, Ind.: Technical Service Department, Dana Parts Co., 1965.

Service Manuals for Various Heavy Duty Automatic Transmissions. Indianapolis, Ind.: Allison Division, General Motors Corp., current edition.

Service Procedure for Ball Bearings. Bristol, Conn.: New Departure Division, General Motors Corp., current edition.

Service Tips. DR–9019. Anderson, Ind.: Delco-Remy Division, General Motors Corp., current edition.

SHAW, STEVEN J. *and* THOMPSON, JOSEPH W. *Salesmanship.* New York: Holt-Dryden and Co., Inc., 1960.

SHERMAN, THEODORE A. *Modern Technical Writing.* Englewood Cliffs, N.J.: Prentice-Hall, Inc., current edition.

Shop Manual for Timken Roller Bearings. Canton, Ohio: Timken Roller Bearing Co., current edition.

SIGBAND, NORMAN B. *Effective Report Writing.* New York: Harper & Row, Publishers, 1960.

SMALL BUSINESS ADMINISTRATION. *Human Factors in Small Business.* Vol. 10. Washington, D.C.: U.S. Government Printing Office, 1965.

———. *Personnel Management.* Vol. 6. Washington, D.C.: U.S. Government Printing Office, 1965.

Small Engines Mechanics. Natchedoches, La.: Vocational Curriculum Development and Research Center, 1964.

SMITH, ALPHEUS W. *and* COOPER, JOHN N. *Elements of Physics.* New York: McGraw-Hill Book Co., Inc., current edition.

SMITH, DONALD H. *The Modern Diesel.* Philadelphia: Chilton Co., Inc., 1956.

SMITH, HARRIS P. *Farm Machinery and Equipment.* New York: McGraw-Hill Book Co., Inc., current edition.

SNYDER, LLEWELLYN R. *Essential Business Mathematics.* New York: McGraw-Hill Book Co., Inc., current edition.

SOUTHER, JAMES W. *Technical Report Writing.* New York: John Wiley & Sons, Inc., 1957.

Spark Plug Service Manual and Tune-Up Procedures. Flint, Mich.: AC Spark Plug Division, General Motors Corp., 1961.

SPATES, THOMAS G. *Human Values Where People Work.* New York: Harper & Row, Publishers, 1960.

STANTON, B. F. *Pipeline Milking—Its Place on Your Farm.* Bulletin No. 1024. Ithaca, N.Y.: Cornell University, 1959.

STEINBERG, WILLIAM F. *and* FORD, WALTER B. *Electricity and Electronics.* Chicago: American Technical Society, 1964.

STEPHENSON, GEORGE E., *Small Gas Engines.* Albany, N.Y.: Delmar Publishers, Inc., 1964.

STEWART, L. E. *Handling Farm Materials.* Bulletin 198. College Park, Md.: University of Maryland, 1963.

STONE, ARCHIE A. *and* GULVIN, HAROLD E. *Machines for Power Farming.* New York: John Wiley & Sons, Inc., 1957.

STRAUSS, GEORGE *and* SAYLES, LEONARD R. *Personnel: The Human Problems of Management.* Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1960.

STREETER, VICTOR L. *Handbook of Fluid Mechanics.* New York: McGraw-Hill Book Co., Inc., 1961.

STRUNK, WILLARD, JR. *The Elements of Style.* Revised by E. B. White. New York: Macmillan Co., 1959.

Suggestions for Teaching Electric Motors for the Farm. New York: Edison Electric Institute, current edition.

THOMPSON, JOSEPH W. *Selling, A Behavioral Science Approach.* New York: McGraw-Hill Book Co., Inc., 1966.

THOMPSON, WILLARD M. *Salesmanship: Concepts, Management, and Strategy.* New York: John Wiley & Sons, Inc., 1963.

TOBOLDT, WILLIAM K. *and* PURVIS, JUD. *Motor Service's Automotive Encyclopedia.* Homewood, Ill.: Goodheart-Wilcox Co., Inc., 1965.

TOSDAL, HARRY R. *Selling in Our Economy.* Homewood, Ill.: Richard D. Irwin, Inc., 1957.

The Tractor Electrical System. Athens, Ga.: American Association for Agricultural Engineering and Vocational Agriculture, current edition.

Transmission Theory. Racine, Wis.: J. I. Case Co., current edition.

Tune-Up Manual. Cleveland: Ignition Manufacturers Institute, 1962.

Tune-Up Manual. Detroit: Automotive Electric Association, 1959.

U.S. DEPARTMENT OF AGRICULTURE. *Drying Ear Corn by Mechanical Ventilation.* Bulletin No. MP–919. Washington: U.S. Government Printing Office, 1963.

———. *Equipment for Cooling Milk on the Farm.* Bulletin No. 2175. Washington: U.S. Government Printing Office, 1961.

———. *Mechanical Silo Unloaders for Upright Silos.* Bulletin No. 2188. Washington: U.S. Government Printing Office, 1962.

———. *Planning the Electric Water System and Plumbing for Your Farmstead.* Bulletin No. MP–674. Washington: U.S. Government Printing Office, 1961.

U.S. Department of Health, Education, and Welfare, Office of Education. *Civil Technology, Highway and Structural Options: A Suggested 2-Year Post High School Curriculum.* OE–80041. Washington: U.S. Government Printing Office, 1966.

———. *Criteria for Technican Education: A Suggested Guide.* OE–80056. Washington: U.S. Government Printing Office, 1968.

———. *Electronic Technology: A Suggested 2-Year Post High School Curriculum.* OE–0009A. Washington: U.S. Government Printing Office, 1967.

———. *Instrumentation Technology: A Suggested 2-Year Post High School Curriculum.* OE–80033. Washington: U.S. Government Printing Office, 1966.

———. *Mechanical Technology, Design and Production: A Suggested 2-Year Post High School Curriculum.* OE–80019. Washington: U.S. Government Printing Office, 1964.

———. *Occupational Criteria and Preparatory Curriculum Patterns in Technical Education Programs.* OE–80015. Washington: U.S. Government Printing Office, 1962.

———. *Pretechnical Post High School Programs: A Suggested Guide.* OE–80049. Washington: U.S. Government Printing Office, 1967.

———. *Scientific and Technical Societies Pertinent to the Education of Technicians.* OE–80037. Washington: U.S. Government Printing Office, 1966.

VanVoorhis, R. H. *and others. College Accounting: Theory and Practice, Part I.* New York: Gregg Publishing Division, McGraw-Hill Book Co., Inc., 1963.

———. *Problems and Working Papers for College Accounting, Part I.* New York: Gregg Publishing Division, McGraw-Hill Book Co., Inc., 1963. (Working papers for Supplemental Problems may also be obtained as well as a practice set.)

Venk, Ernest A. *and* Billiet, Walter E. *Automotive Engines Maintenance and Repair.* Chicago: American Technical Society, current edition.

———. *Automotive Fundamentals.* Chicago: American Technical Society, current edition.

Verwiebe, Frank L. *and others. Physics—A Basic Science.* Princeton, N.J.: D. Van Nostrand Co., Inc., 1962.

Walker, John R. *and* Plevyak, Edward J. *Industrial Arts Drafting.* Homewood, Ill.: Goodheart-Wilcox Co., Inc., 1964.

Watson, Bruce *and* Tarr, William E., Jr. *The Social Sciences and American Civilization.* New York: John Wiley & Sons, Inc., 1964.

Weiss, E. B. *The Vanishing Salesman.* New York: McGraw-Hill Book Co., Inc., 1962.

Welding Handbook. Section II. New York: American Welding Society, 1963.

Wetzel, Guy F. *Automotive Diagnosis and Tune-Up.* Bloomington, Ill.: McKnight and McKnight, current edition.

What You Should Know About Farm Tires. Akron, Ohio: B. F. Goodrich Co., current edition.

White, Harvey E. *Descriptive College Physics.* Princeton, N.J.: D. Van Nostrand Co., Inc., current edition.

Wiksell, Wesley A. *Do They Understand You? A Guide to Effective Oral Communication.* New York: Macmillan Co., 1960.

Wilson, Howard. *Living with Yourself.* Deerfield, Ill.: Administrative Research Associates, 1962.

———. *Understanding People.* Deerfield, Ill.: Administrative Research Associates, 1962.

Wilson, Leonard L. *Farm and Power Equipment Retailers Handbook.* St. Louis, Mo.: National Farm and Power Equipment Dealers Association, 1964.

Wright, F. B. *Rural Water Supply and Sanitation.* New York: John Wiley & Sons, Inc., 1956.

Zelko, Harold *and* Dance, Frank. *Business and Professional Speech Communication.* New York: Holt, Rinehart, and Winston, 1965.

Zetler, Robert *and* Crouch, W. George. *Successful Communication in Science and Industry.* New York: McGraw-Hill Book Co., Inc., 1961.

Reference Periodicals

Administrative Management. Geyer-McAllister Publications, 212 Fifth Avenue, New York, N.Y. 10010.

Agricultural Engineering. American Society of Agricultural Engineers, 420 Main Street, St. Joseph, Mich. 49085.

Business Management. Management Magazines, Inc., 22 West Putnam Avenue, Greenwich, Conn. 06830.

Farm Journal. Farm Journal, Inc., Philadelphia, Pa. 19105.

Farm Power Equipment. NRFEA Publications, Inc., 2340 Hampton Avenue, St. Louis, Mo. 63139.

Hoard's Dairyman. W. D. Hoard & Sons Co., 28 Milwaukee Avenue West, Fort Atkinson, Wis. 53538.

Implement and Tractor. Implement & Tractor Publications, Inc., 1014 Wyandotte Street, Kansas City, Mo. 64105.

Journal of Farm Economics. C. Del Mar Kearl, Department of Agricultural Economics, Cornell University, Ithaca, N.Y. 14850.

The Office. Office Publications, Inc., 73 Southfield Avenue, Stamford, Conn. 06904.

Personnel. American Management Association, Inc., 135 West 50th Street, New York, N.Y. 10020.

Personnel Administration. Society for Personnel Administration, 1221 Connecticut Avenue NW. Washington, D.C. 20036.

Personnel Journal. Personnel Journal, Inc., 100 Park Avenue, Swarthmore, Pa. 19081.

Successful Farming. Meredith Publishing Co., 1716 Locust Street, Des Moines, Iowa. 50303.

Supervisory Management. American Management Association, Inc., 135 West 50th Street, New York, N.Y. 10020.

APPENDIXES

Appendix A.—Selected List of Scientific, Trade, or Technical Societies and Associations

A list of some of the professional, scientific, trade, and technical societies and associations concerned with agricultural equipment technology and its applications may be a useful source of instructional information and reference data.

The selected list which follows is not a complete listing of all such organizations. Inclusion of an organization on this list does not imply special approval, nor does omission imply disapproval.

It is suggested that teachers and others who desire information from the organizations listed below address their inquiry to the "Executive Secretary" of the organization. A request for information about the organization and its services or for specific information usually can be answered promptly by them. -

AMERICAN ASSOCIATION FOR AGRICULTURAL ENGINEERING AND VOCATIONAL AGRICULTURE. Coordinator's Office, Agricultural Engineering Building, University of Georgia, Athens, Ga. 30601.

An organization of agricultural colleges and divisions of vocational agriculture devoted to the improvement of agriculture through better information and teaching aids.

Publications: Variety of teaching materials and visual aids.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS (ASAE). Box 229, St. Joseph, Mich. 49085.

A society whose objectives are to promote the science and art of engineering in agriculture, to encourage original research, to foster agricultural engineering education, and to advance the standards of agricultural engineering.

Publications: *Agricultural Engineering*, monthly; *Transactions*, quarterly; *Agricultural Engineers' Yearbook*.

AMERICAN SOCIETY OF CERTIFIED ENGINEERING TECHNICIANS (ASCET). 2029 K Street NW., Washington, D.C. 20006.

An organization of persons certified by the Institute for the Certification of Engineering Technicians as skilled craftsmen whose training and experience qualify them to provide technical support and assistance to registered professional engineers and engineering departments.

Publications: *ASCET Newsletter*, monthly; *President's Letter*, quarterly; *ASCET Magazine*, annual.

AMERICAN SOCIETY FOR ENGINEERING EDUCATION (ASEE). DuPont Circle Building, 1346 Connecticut Ave. NW., Washington, D.C. 20036.

A professional society of college and university engineering teachers and others interested in engineering education. Its purpose is to advance education and research in engineering, science, and related fields. It conducts an annual College-Industry Conference, sponsors short summer schools and workshops, carries out special research projects, administers visiting engineering programs for colleges and junior colleges and industrial fellowship programs.

Publications: *Journal of Engineering Education*, 10-yr.; *Machine Design and Manufacturing Processes Bulletin*, quarterly; *Heat-Power News and Views*, quarterly; *Journal of Engineering Graphics*, 3-yr.; *Yearbook-Directory; Engineering College Research Review*, biennial; *Division Newsletters—Electrical Engineering*, 3-yr.; *Industrial Engineering*, annual; *Technical Institute*, biennial; also publishes research reports, brochures, reprints.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM). 1916 Race Street, Philadelphia, Pa. 19103.

A Society in which engineering scientists and skilled technicians hold membership as individuals or as representatives of business firms, government agencies, educational institutions, laboratories. It promotes the knowledge of materials of engineering and the standardization of specifications and testing methods.

Publications: *Materials Research and Standards Journal*, monthly; *Yearbook, Index to Standards*, annual; *Book of Standards*, annual; also publishes numerous technical papers and reports.

AMERICAN STANDARDS ASSOCIATION (ASA). 10 East 40th Street, New York, N.Y. 10016.

An association of industrial firms, trade associations, technical societies, consumer organizations, and government agencies serving as a clearing house for nationally coordinated, voluntary safety, engineering and industrial standards.

Publications: *Magazine of Standards*, monthly; *Newsletter*, monthly.

AMERICAN TECHNICAL EDUCATION ASSOCIATION, INC. (ATEA). 22 Oakwood Place, Delmar, N.Y. 12054.

An association of educators, teachers, and individual leaders interested in technical education at the high school and post high school levels.

Publications: *Newsletter*, bimonthly; *Convention Addresses* annual.

AMERICAN WELDING SOCIETY (AWS). 345 East 47th Street, New York, N.Y. 10000.

A professional engineering society in the field of welding. Special committees include: Symbols, Definitions and Charts, Filler Metal, Safety Recommendations, Standard Qualification Procedures, Resistance Welding, Metallizing, Brazing and Soldering, Building Codes, Automotive Welding, Piping and Tubing.

Publications: *Welding Journal*, monthly; *Welding Handbook*, annual.

AUTOMOTIVE ELECTRICAL ASSOCIATION (AEA). 16223 Meyers, Detroit, Mich. 48235.

An association of firms engaged in the manufacture, distribution, and service of specialized original equipment units and parts for automobiles, trucks, and tractors. It carries on a technical training program.

Publications: Catalogs, technical manuals, specification manuals, tune-up charts.

DIESEL ENGINE MANUFACTURERS ASSOCIATION (DEMA). 122 East 42nd Street, New York, N.Y. 10017.

An association of manufacturers of diesel and gas engines.

Publications: *Standard Practices for Stationary Diesel and Gas Engines*, every 5 yrs.

EDISON ELECTRIC INSTITUTE (EEI). 750–3d Avenue, New York, N.Y. 10017.

A trade association of investor-owned electric light and power companies which makes known to all electric companies new devices and methods developed to improve electric service.

Publications: *EEI Bulletin*, monthly; *Newsletter; Electric Utility Industry Statistics.*

FARM AND INDUSTRIAL EQUIPMENT INSTITUTE (FIEI). 410 North Michigan Avenue, Chicago, Ill. 60611.

An organization of manufacturers of farm implements, machinery, light industrial equipment, and suppliers of materials and services. Councils and committees include: Agricultural Research, Barn Cleaners, Cattle Feeders and Silo Unloaders, Barn Equipment, Crop Dryers, Engineering, Farm Safety, Fasteners, Fertilizer, Foreign Trade, Garden Equipment, Industrial Equipment, Livestock Equipment, Loading Rules, Materials, Milking Machines, Operators Manuals, Poultry Industry, Public Relations, Sprayers and Dusters, Soil and Water Conservation, Statistics.

Publications: *FIEI Letter*, bimonthly; *Farm Equipment Industry Facts*, annual; *Land of Plenty; Survey of Agricultural Engineering Projects at Land Grant Colleges in the United States, Canada, and Puerto Rico.*

FARM EQUIPMENT MANUFACTURERS ASSOCIATION (FEMA). 230 South Bemiston, St. Louis, Mo. 63105.

An association of manufacturers of "short line" specialized farm equipment.

Publication: *Shortliner*, semi-monthly.

FLUID POWER SOCIETY. Box 49, Thiensville, Wis. 53092.

A technical society for individuals interested in fluid power technology, sponsored by the National Fluid Power Association. The purpose of the society is twofold: the updating and upgrading of members' knowledge of the technology, and cooperating with schools and other appropriate agencies in developing formal courses and curriculums.

Publications: *Fluid Power Society News*, monthly.

IGNITION MANUFACTURERS INSTITUTE. 1008 Standard Building, Cleveland, Ohio 44113.

An association of independent manufacturers of ignition parts for internal combustion engines dedicated to the promotion of better relations between manufacturers, distributors and the service trades. Its objectives are to maintain high standards of quality and precision manufacture on the part of its members and to promote quality work by servicemen.

Publications: *Tune-Up Manual.*

INSTITUTE FOR THE CERTIFICATION OF ENGINEERING TECHNICIANS (ICET). 2029 K Street, NW., Washington, D.C. 20006.

An examining body which determines competency of technicians who work for and under the direction of engineers. It issues certificates for three grades: junior engineering technician, engineering technician, and senior engineering technician. It is sponsored by the National Society of Professional Engineers.

JOINT INDUSTRIAL COUNCIL (JIC). 2139 Wisconsin Avenue, NW., Washington, D.C. 20007.

An organization comprised of producers and users of industrial machinery and equipment. It provides direction, coordination, and continuity of effort in the development, advancement, and referral to the ASA of standards which will encourage the safe and reliable application of controls to machines and equipment used in industrial applications.

NATIONAL FARM AND POWER EQUIPMENT DEALERS ASSOCIATION (NFPEDA). 2340 Hampton Avenue, St. Louis, Mo. 63139.

An organization of retailers of farm machinery, implements, light industrial machinery, tools, vehicles, and related supplies. It compiles statistics and conducts programs of management training, government and trade relations. It sponsors insurance program for members and their employees.

Publications: *Farm and Power Equipment*, monthly; *Official Tractor and Farm Equipment Guide*, 2-yr.; *Light Industrial Equipment Guide*, 2-yr.; *Management Bulletins*, monthly.

NATIONAL FLUID POWER ASSOCIATION (NFPA). Box 49, Thiensville, Wis. 53092.

An association of manufacturers of components such as pumps, valves, and cylinders used in transmitting power by means of a fluid (gas or liquid) under pressure (hydraulic or pneumatic) used in materials-handling, automotive, agricultural, and other machinery. Special committees include Management Services, Marketing, Education, Technical, Public Relations.

Publications: *NFPA News*, monthly.

NATIONAL SAFETY COUNCIL. 425 North Michigan Avenue, Chicago, Ill. 60600.

An organization whose objective is to reduce the number and severity of all kinds of accidents by gathering and distributing information about causes of accidents and ways to prevent them.

Publications: *Safety Education*, monthly; *Farm Safety Review*, bimonthly; *Accident Facts*, annual; also publishes posters, technical publications, and booklets.

SOCIETY OF AUTOMOTIVE ENGINEERS, INC. (SAE), 485 Lexington Avenue, New York, N.Y. 10017.

A professional society of engineers in the field of self-propelled ground, flight, and space vehicles. It promotes the arts, sciences, standards, and engineering practices related to the design, construction, and utilization of self-propelled mechanisms, prime movers, components, and related equipment. Special subcommittees include Engineering Education; Farm, Construction, and Industrial Machinery; and Fuels and Lubricants.

Publications: *SAE Journal*, monthly; *SAE Transactions*, annual; *SAE Handbook* (book of standards), annual; *Technical Progress Series*, 3 vol./yr.; also publishes over 100 papers dealing with automotive industry practices and about 750 technical papers annually.

Appendix B.—Occupational Experience Plans and Forms

The primary purpose of cooperative occupational experience in agricultural equipment technology is the development of on-the-job competence in students. Occupational experience can be defined as student participation in the operation and management of an agricultural business or a farm, under a plan approved and supervised by the institution. Supervised occupational experience in agriculture is essential for an adequate educational program which will develop competencies needed by a student for gainful employment in an agricultural occupation. Essentially, the cooperative plan utilizes the work situation as a "school laboratory"; the competencies are developed under supervision, while the related instruction is provided in the school.

Objectives of such plans include the following:

1. To prepare each student for gainful employment in an occupation in his field of interest.
2. To provide the student with the opportunity to gain a sense of responsibility for a job.
3. To provide the student with the opportunity to develop positive on-the-job personality traits.
4. To provide the student with the opportunity to apply in practice the theory and knowledge gained in the classrooms and laboratories.
5. To provide the student with the opportunity to learn to cooperate and work with fellow employees and customers.
6. To provide students with an opportunity to gain knowledge and experience in aspects of the job not available at the school.
7. To enlist cooperation of prospective employers to insure an effectively supervised training program.

It is usually necessary to enlist the aid of an advisory committee or subcommittee selected for the area of specialization when a supervised occupational program is initiated. This committee's primary function is to assist in determining and selecting appropriate work stations for the students. The facilities, personnel, and training opportunities available at each work station are factors to consider in selecting possible student stations. This information should be gathered in personal interviews with each potential cooperating employer in order to determine his interest in carrying out the program.

After employers have agreed to cooperate in the program by providing work stations and before students have begun work assignments, a cooperative work agreement should be prepared with each employer. These agreements should include a statement of philosophy and the responsibilities of all parties. They should specify the particular occupational experiences, time requirements, wages, insurance, taxes, working hours, and time-off conditions.

Progress and evaluation records should be completed for each student and filed with the permanent student records at the school. The following information should be included:

Employer's rating report
Instructor's rating report
Visitation reports
Copies of training plan
Copies of training agreement
Evaluation forms

Suggested guidelines and reports for the occupational training portion of the agricultural equipment curriculum follow.

I. GOAL

To give the student occupational experience which will enable him to acquire skills and gain practical knowledge necessary in the agricultural equipment business on a farm or a related farm production enterprise.

II. GENERAL

The occupational training period is__________________.
(Dates)

The occupational program is arranged on an individual basis between the student, the manager, and the course coordinator.

Occupational training agreements may be terminated by the employer, the student, or the coordinator, provided there is sufficient reason. It is understood that a minimum of 2-weeks' notice will be given to all parties and that all measures will be taken to insure fair treatment of all concerned.

While in occupational training, the student is registered at the school and is subject to the jurisdiction and discipline of the school. The student is required to submit a weekly report, due on the Wednesday following the week reported.

Address all correspondence to:

Name____________________________________

Address__________________________________

III. STUDENT RESPONSIBILITIES

The student agrees to work with his selected organization for the period of occupational training unless terminated as provided for in paragraph 3 under the preceding heading "GENERAL."

The student agrees to conform with the normal work hours of the organization. (It may be necessary to work longer hours during a busy season.)

The student is expected to:

Perform in deed and word to the employer's best interest.
Perform all duties requested by the employer cheerfully and to the best of his ability.
Refrain from discussing his employer or his employer's business without permission and certainly never to his employer's detriment.
Report to work on time.
Be neat in appearance and properly dressed for work.
Be courteous at all times.
Be a credit to himself, his employer, and the school.

Complete all reports and forward them to the coordinator by Wednesday of the week following the week reported.

Collect information necessary for a detailed final report which will be a critique of his occupational activities.

The student will advise the coordinator of his address and advise him of any changes.

The student will request permission from the employer and the coordinator before taking time off during the occupational training period.

IV. EMPLOYER RESPONSIBILITIES

The employer agrees to employ the student for the occupational training period unless terminated as provided for in Paragraph 3 of the preceding "GENERAL" heading.

The employer agrees to pay the student the starting wages agreed upon. Increases in pay may be given as the employer sees fit.

The employer should give the student the opportunity to work on different jobs during the occupational training period so he may acquire the maximum number of skills and become familiar with the various phases of the business.

The employer is expected to counsel the student at various times during the training period so that the student will have an opportunity to question the employer about various operations.

The employer agrees to notify the coordinator regarding any problems that may develop relative to the student's conduct or the period of employment.

The employer agrees to submit an evaluation of the trainee bimonthly and at the end of the occupational training.

V. COORDINATOR RESPONSIBILITIES

The coordinator is expected to be present when the occupational training program is being developed.

The coordinator will counsel the student and the employer once each 2 weeks to determine the student's progress and to advise him concerning his program of study.

The coordinator will strive to promote harmony and cooperation among the employer, the student, and the school. His services are available in any way that may be beneficial to the training program.

STUDENT'S OCCUPATIONAL EXPERIENCE REPORT IN AN AGRICULTURAL BUSINESS

To the Student:

General Instructions: You will be required to submit a comprehensive term paper on your experiences during occupational training. The report will be graded and will become a part of your occupational experience record. The report will be graded on completeness, accuracy, and neatness.

You are expected to submit the report in a standard report cover (8½ x 11), complete with title page and table of contents. The report must be typed or handwritten in ink on plain white (8½ x 11) paper. Graph paper may be used where appropriate. Maps and drawings must be in ink on plain white paper. You may use a prepared county map for I–A below.

Suggested Outline

I. The Trade Area
  A. Draw or obtain a map of the county or counties served by your training station and sketch in the approximate trade area served. Also show the location of all competition within 20 miles.
  B. Make a table listing production from agricultural enterprises for the county and for the State during the last 5 years.
II. The Agricultural Equipment Business
  A. History of the business
    1. When established
    2. Type of organization
    3. Number of stockholders
    4. Number of employees
    5. Recent changes
    6. Major services performed by the business and your opinion on how and why these services should be improved or new ones added. (Look at service from the standpoint of need in the trade area.)
  B. Building layout. Make a detailed drawing of the business. Show the location of all equipment and storage areas. This drawing should be to scale. Be sure you show the dimensions on drawings. Use one drawing for each floor in the business.
  C. Equipment. Make a list of all specialized equipment available.
  D. Rearrangement. Give your opinion of how the layout of the building could be rearranged to do a better job of serving the customer.
    1. Illustrate with drawings.
    2. Justify these changes in terms of economics.
  E. Products. List the product lines handled by the business. Should any product lines be added? Should any product lines be dropped?
  F. List the strong and weak points of the business.
III. Your Role in the Business
  A. Jobs you performed in the business and the percentage of time spent on each job. (This should be a summary of your weekly reports.)
  B. Which jobs did you enjoy most? Which jobs did you dislike?
  C. In which areas were you given major responsibility?

D. In what phase of the business do you feel you would best fit? Why?
E. Describe your relationship with other employees.
F. How could occupational training have been improved? Consider this in terms of the manager's responsibility, the coordinator's responsibility, and your responsibility.

Address all correspondence to:

Name ______________________

Address ______________________

____

PLAN OF OCCUPATIONAL EXPERIENCE TRAINING PROGRAM IN AN AGRICULTURAL BUSINESS

Name ______________________ (Last) (First) (Middle)

Home Address ______________________ (Number and Street) (City) (State)

Placement Training Address ______________________

Landlord's Name ______________________

Name of Employer ______________________

Address of Employer ______________________

Dates of Employment: Beginning ______________ Ending ______________

Areas in which students will receive instruction and remuneration:

	Approximate hours in each area	
	Scheduled	Finished to date*
I. MACHINERY AND EQUIPMENT ASSEMBLY		
A. Instruction manual use and special set-up tips		
B. Assembly and pre-delivery service		
II. SERVICE WORK		
A. Engine overhaul		
B. Transmission work		
C. Final drive		
D. Front end and steering		
E. Lubrication, air and oil filters		
F. Cooling system		
G. Small engine work		
H. Machinery repair, i.e., baler		
I. Equipment repair, i.e., barn cleaner		
J. Service calls		

See footnote at end of table.

	Approximate hours in each area	
	Scheduled	Finished to date*
III. PARTS DEPARTMENT A. Introduction to card control system and determining stock level		
B. Assist with parts ordering		
C. Handle a special parts order		
D. Post sales to inventory cards		
E. Check existing inventory with inventory records		
F. Locate parts		
G. Assist with counter trade		
H. Assist with receipt of stock order		
IV. SALES DEPARTMENT A. Attend weekly sales meetings		
B. Review slide films available		
C. Product knowledge		
D. Competitive prices		
E. Demonstration		
F. Asking for the order		
G. Explaining financing		
H. Closing the deal		
I. Sales follow-up		

*Keep accumulated record of hours worked recorded in pencil. Revise totals from weekly reports before they are mailed to the coordinator.

Daily Hours of Work: ______________ a.m. to ______________ p.m.

Days per Week: ______________

Remuneration—Employer is to pay this student per hour: ______________

or per week: ______________

or per month: ______________

Time-and-a-half (will, will not) be paid for overtime.

Signed: Approved by Employer ______________

Approved by Employee ______________

Approved by Counselor ______________

AGRICULTURAL EQUIPMENT TRAINEE EVALUATION FORM

(To Be Completed by the Employer)

Check the description that most nearly describes the trainee in each of the categories listed below.

	Excellent	Above average	Average	Below average	Unsatisfactory
QUALITY of work					
ATTITUDE concerning work					
ATTITUDE toward people					
APPEARANCE					
RELATIONSHIPS employee-employer					
RELATIONSHIPS employee-customer					
RELATIONSHIPS public					
RESPONSIBILITY assumed for job					
INTEREST					

STUDENT'S NAME____________________ EMPLOYER'S SIGNATURE____________________

Please circle the grade you would give this student on his overall performance. Compare the student's performance with other young men just starting in the agricultural equipment business.

A B C D F

Please list your comments on the back of this form.

Placement and followup of graduates of technical training programs are necessary functions which any institution must provide for students. The placement program must be a well organized project which serves the personal needs of the individuals and organizations involved. It therefore requires a thorough knowledge of the personalities and needs of both students and employers in order to be effective and valuable for both parties.

Preparation for placement and followup begins when the prospective student applies to the institution for admission, and it should continue after he graduates until it is no longer possible to secure responses to the communications sent to him.

Many types of data for each student must be collected to prepare a complete record. Teachers are best able to secure this information; however, they will only be able to do so if they are friendly, interested in, and accessible to the student both in and outside of the classroom. Every person who teaches must genuinely strive to know and understand his students if the placement program is to be effective.

The following suggested placement practices might be employed by the agricultural equipment technology staff:

1. Prepare and use departmental basic information card for each student and affix the student's picture to this card.
2. Hold departmental meetings regularly to discuss students and their accomplishments. A complete record of student information could be made on the departmental basic information card.
3. The department chairman should teach at least one freshman course so he can become acquainted with the students and their objectives.
4. Student evaluation and course grades should be discussed by the department staff at the end of each semester before the final assignment of grades.
5. Student evaluation reports should be filed with the student's permanent records.
6. Each instructor and department head should serve as an advisor to some of the students in his classes. A student should be encouraged to seek counsel from any department member with whom he has established particular rapport.
7. Students should be encouraged to crystallize their post-graduation objectives (i.e., type of job desired or advanced education plans) early in their second year. They should also have formulated plans for achieving their goals at this time. Résumés should then be prepared and applications for positions made as early as possible.
8. Students should be placed on jobs for which they are best qualified.

Appendix C.—Representative Laboratory Experiences

The laboratory exercises contained in this section are representative examples of laboratory activities which might be conducted in the various agricultural equipment technology courses.

HYDRAULICS II (Equipment Applications)

Objectives:

1. To study the components in a complete hydraulic system on a piece of equipment.
2. To study the relationship of the different components in the hydraulic system.

Laboratory Procedure:

1. Identify the parts of the hydraulic system on the two fork-lift trucks in the lab.
2. Draw a schematic diagram of the hydraulic system being studied.

Laboratory Report:

Hand in a schematic plan of the hydraulic system drawn with all components represented. Color code the lines as follows:

reservoir to pump—green
pump to control valves—red line
valve to tilt cylinders (forward tilt)—dotted red line
valve to tilt cylinders (rear tilt)—dotted red line
valve to lift cylinder (up)—dotted red line
valve to lift cylinder (down)—dotted red line
control valves to reservoir—blue line

Suggestions for Drawing:

1. Use large sheet of paper.
2. Select scale that will fill the paper.
3. Plan location of parts in schematic to avoid crossing of lines.
4. Use colored pencils, felt-tip pens, or water colors in coloring lines.
5. Carefully measure each cylinder and line in order to determine correct size for diagram.
6. Use notes to label each part of the system.

FARM POWER I (GAS ENGINES) INSPECTION REPORT

Name ______________________________
Make ______________ Model ______________ Serial No. ______________

Dynamometer Test

RPM—Specs ______________ Actual ______________ Adjusted ______________
H.P.—Specs ______________ Actual ______________ Adjusted ______________
Tuneup work done:
Work apparently needed:

Cylinder Head

Torque ______________ ft.-lbs.
Valves & valve seats
Valve clearance: Intake ______________
Exhaust ______________
Valve & Seat Face: Intake ______________
Exhaust ______________
Seat Width:
Stem Diameter: specs ______________ actual ______________
Valve Guides:
Diameter: specs ______________ actual ______________
Stem to guide clearance: Max. allowed ______________ actual ______________
Valve Springs:
Free length: specs ______________ actual ______________
Compressed length: ______________
Pressure: specs ______________ actual ______________

Cylinder Head—Continued

Rocker Arms:
Shaft diameter: specs________________ actual________________
Rocker arm clearance: specs________________ actual________________
Torque

Engine Block:

Camshaft
Journal diameter: specs________________ actual________________
End play: specs________________ actual________________
Bearing clearance: specs________________ actual________________
Pistons, Bore & Rings
Bore:
Out of round: specs________________ actual________________
Taper: specs________________ actual________________
Diameter: specs________________ actual________________
Piston:
Skirt diameter:
Parallel to pin: specs________________ actual________________
Right angle to pin: specs________________ actual________________
Skirt line clearance: specs________________ actual________________
Rings:
End gap:
Compression: specs________________ actual________________
Oil Ring: specs________________ actual________________
Side Clearance:
Compression: specs________________ actual________________
Oil Ring: specs________________ actual________________
Piston Pins:
Pin diameter: specs________________ actual________________
Pin bore: (in piston) specs________________ actual________________
Pin bore in rod bushing: specs________________ actual________________
Bearing clearance: specs________________ actual________________
Connecting Rod
Rod journal diameter: specs________________ actual________________
Rod side clearance: specs________________ actual________________
Bearing clearance: maximum allowed________________
Rod bolt torque: specs________________ actual________________
maximum allowed________________
Crankshaft
Journal diameter: specs________________ actual________________
End play: specs________________ actual________________
Bearing clearance: specs________________ actual________________
Out of round: maximum allowed________________ actual________________
Torque:

Reconditioning (Parts and Other Work)

Part name and No.	*Size*	*Reason*	*Cost*

Other Work: (i.e., Turn Down Crankshaft)

LABORATORY GUIDE FOR FIELD OPERATION AND ADJUSTMENT OF MACHINES

For each type of machine being studied (e.g., hay baler) do the following:

1. Name of machine____________________
2. Make or makes of machines____________________
3. Model of each machine____________________
4. Serial number for each machine____________________
5. List checks and operations which should be made on machine before going to the field:
   a.____________________
   b.____________________
   c.____________________
   d.____________________
   and____________________
6. How and where is it best to start in the particular field? Why? Outline procedure for continuation in the field.
7. Speeds for field operation for each machine:
   PTO____________________
   Ground____________________
8. Do whatever applies for the following:
   length of cut____________________
   height of cut____________________
   depth of plant____________________
   other____________________
9. Characteristics of a good job:
   a.____________________
   b.____________________
   c.____________________
   d.____________________
10. Identify all possible field adjustments and show what happens if they are incorrect.
11. List safety measures that should be observed in the operation of field machines.

FARM POWER II

LABORATORY REPORT—FUEL INJECTION NOZZLE

Name____________________

Part I

Fill in and secure instructor's approval before proceeding with Part II.

1. Name of injector- 1.____________
2. a. Injection pressure before disassembly- - - - - - - - - 2. a.____________
   b. The correct pressure should be- - - - - - - - - - - - b.____________

Part I—Continued

3. Draw a sketch of the spray characteristics as observed while testing before disassembly. 3. ____________
4. a. Were the spray characteristics good before disassembly............ 4. a. ____________
   b. If not, what was the trouble............ b. ____________
5. Open or closed type............ 5. ____________
6. Method of adjusting injection pressure............ 6. ____________
7. Trace the fuel passages............ 7. Answer orally
8. Pintle or hole nozzle............ 8. ____________
9. With what type combustion chamber would you find this nozzle being used? 9. ____________
10. a. Is this injector designed for internal cooling?............ 10. a. ____________
    b. How can you determine?............ b. ____________
11. Draw a sketch to show internal construction of the nozzle............ 11. ____________

Part II

Fill in and secure instructor's approval before proceeding with Part III.

INSTRUCTOR'S CHECK ____________

1. Which parts may be lapped?............ 1. ____________
2. Which parts may not be lapped?............ 2. ____________
3. Which parts should be replaced as a pair or as a unit?............ 3. ____________
4. What size wire was used for cleaning the nozzle?............ 4. ____________
5. Number and angle of holes in the nozzle tip............ 5. ____________
6. What lapping compound may be used for this precision work?............ 6. ____________
7. List two good carbon dissolving solutions for soaking these precision parts. 7. a. ____________
   b. ____________
8. List the parts which are poor but which can be repaired............ 8. ____________
9. List the parts which should be replaced............ 9. ____________

Part III

Fill in and secure instructor's approval before turning in equipment.

INSTRUCTOR'S CHECK ____________

1. Is it necessary to bleed this nozzle for air binds?............ 1. ____________
2. How would you bleed this injector?............ 2. Answer orally
3. Injection pressure after assembled and set?............ 3. ____________
4. If a new pressure adjusting spring had been installed, what should the opening pressure be? 4. ____________
5. What effect would too low an opening pressure have on the spray characteristics? 5. ____________
6. Draw a sketch of the spray charcteristics as observed while testing, after injector has been set for correct opening pressure. 6. ____________
7. List the troubles you might encounter with this nozzle............ 7. ____________
8. How would you locate and correct each of the items listed in question 7? 8. ____________
9. Write up an order for a new nozzle tip for this injector............ 9. ____________

MACHINERY LABORATORY REPORT ON PLOWS

Report Due ____________
(Date)

Make of Plow ____________
Number of bottoms ____________
Type ____________
Model Number ____________
Serial Number ____________

Write a discussion-type answer to each of the following questions:

1. Develop a list of benefits to be derived from plowing.
2. Give your criteria for determining if a particular field has been properly plowed (e.g., correct depth).
3. With a labeled sketch, diagram, or picture, show the main parts of the plow.
4. With a labeled sketch, diagram, or picture, show all the parts of a plow bottom. Concisely state the primary function of each part.
5. Draw a sketch showing plan for plowing a field 40 rods wide by 80 rods long, including number of lands, number of back furrows, and number of dead furrows.
6. A tractor has the following drawbar pull in these gears: (According to Nebraska tests)
   2nd gear—7,621 pounds drawbar pull
   3rd gear—5,289 pounds drawbar pull
   4th gear—4,057 pounds drawbar pull
   Use only 70 percent of listed pull and determine the largest plow that may be used for each gear. Use 14″ bottoms and assume the maximum unit draft is 12 p.s.i. Assume 7″ plowing depth. (Unit draft is pounds pull per square inch of furrow slice.)
7. Which of the above plows would be most efficient for the field in question 5?
8. Develop a list for checking your plow in the shop before taking it to the field at the beginning of the season or during the nonoperating time. Indicate which of these might be a daily check.
9. What would you suggest to correct each of the following problems for both mounted- and pull-type plows.
   a. Furrows are uneven in height and width.
   b. Plow is slow to raise.
   c. Plow is slow to enter ground.
   d. There is excessive wear on the underside of the share points.
   e. The hitch catches and drags excessive trash.
   f. The bottoms fail to scour.
   g. There is excessive wear on rear landside.
   h. There is excessive draft.
   i. There is excessive sidedraft on the plow or on the tractor.
   j. The depth of the furrow is uneven.
   k. There is excessive tractor wheel slippage.
10. Describe proper field adjustment for each of the following:
    a. rolling colter
    b. jointer and rolling colter combination
    What is the exact function of each of the rolling colter and jointer?
    What are some of the conditions which might affect how these would be set?

LABORATORY PROJECT ON GRAIN COMBINES

Report due at end of laboratory period.

Make____________________________________

Model____________________________________

Size____________________________________

Serial Number______________________________

1. *Cutting:*
   Compare the cutting mechanism with the mowers studied in class.
   Reel:
   Check speed________________RPM'S
   Measure: a. Height________________inches
   b. Forward position________________inches
   Describe condition for which reel is set.
2. *Feeding:*
   Are the chains on the elevator set at the proper tension?
   Measure auger clearance________________inches
3. *Threshing:*
   Cylinder type____________ 1, ____________ 2, ____________ 3, ____________
   Cylinder speed reading____________ 1, ____________ 2, ____________ 3, ____________
   RPM'S

What should it be for __________ crop?
Measure concave clearance __________ inches
For the __________ change the concave clearance for __________
Make Crop
1, __________ 2, __________ 3, __________
What should it be for __________ 1, __________ 2, __________ 3, __________
Crop
Check beater speed __________ 1, __________ 2, __________ 3, __________
RPM'S
For the __________ change the cylinder speed for __________
Make Crop
1, __________ 2, __________ 3, __________

INSTRUCTOR'S O.K. __________

4. *Separating:*
Name of mechanism __________
Describe its action:
____
____
____

5. *Cleaning:*
Size of air intake adjustment:
Measure __________ inches
Adjust for __________ crop
Air deflector setting __________
Adjust for oats __________
For the __________ change the chaffer or upper sieve setting for __________
Make Crop
Adjust for oats __________
Adjustment for varying crop conditions:
a. very dry
b. very damp
c. large number of weeds
d. wind damaged or rain lodged crop

Tailings:
Describe the path of tailings:
____
____
____

6. *Grain Handling:*
Describe the path of cleaned grain:
Grain tank capacity __________ 1, __________ 2, __________ 3, __________
Bushels
7. Check for machine and field losses.
8. *Protective devices:*
Describe the location and type of all devices which prevent damage to the machine.
____
____
____
9. Develop a list of steps for preparing the combine for storage.
10. How would you prepare this machine for combining corn?
a. __________
b. __________
c. __________

INSTRUCTOR'S O.K. __________

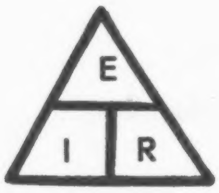
APPLIED PHYSICS II (Electricity)

PRINCIPLES OF ELECTRICITY AND ELECTRICAL MEASUREMENTS

Objective: To prove how Ohm's Law applies to series and parallel circuits.

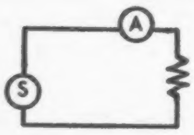
Facts and Information

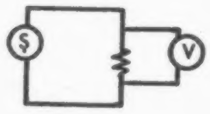
1. The physics books state Ohm's Law as follows:
   The current flowing in an electrical circuit is directly proportional to the impressed voltage and inversely proportional to the resistance.
2. In formula form, Ohm's Law states that:

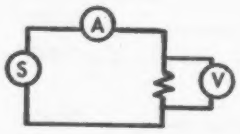


$$I=\frac{E}{R};\ E=IR;\ R=\frac{E}{I}$$

3. A voltmeter is used to measure the voltage across a circuit. It is always connected in parallel in the circuit.
4. An ammeter is used to measure the current in a circuit. It must be connected in series in the circuit. Care should be taken to avoid damaging the meter by overloading it.
5. Schematics showing how to measure current, voltage, and resistance of a circuit:







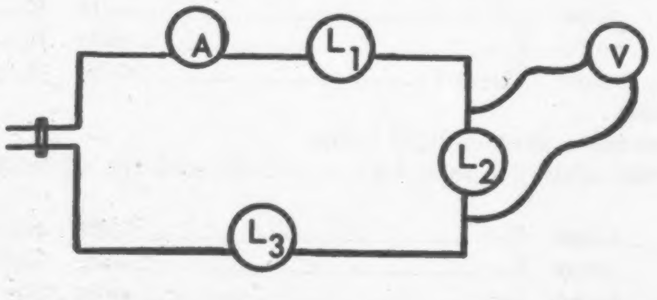
6. In a series circuit:
   a. The current (I) is the same in every part of the circuit.
   b. The resistance (R) is equal to the sum of the separate resistances.
   c. The voltage applied is equal to the sum of the voltages across the units of resistance in the circuit.
7. In a parallel circuit:
   a. The total current is equal to the sum of the currents through the parts.
   b. The resistance is equal to the reciprocal of the sum of reciprocals of each resistance.

$$R_e=\frac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\text{etc.}}$$

   c. The voltage across each unit is the same throughout the circuit.

Procedure

A. **Series circuit with equal loads**
Connect an ammeter, voltmeter, and three sockets in series as diagrammed below. Use cone heaters in the sockets. *DO NOT PLUG IN OUTLET UNTIL IT HAS BEEN CHECKED BY THE INSTRUCTOR.*



Type of load cone heater ______________________________
Watts ______________________________
Volts ______________________________

Measure and record the following readings:

I = ____________________ amps
E_1= ____________________ volts
E_2= ____________________ volts
E_3= ____________________ volts

E_{1+2} = ____________________ volts
E_{2+3} = ____________________ volts
E_{1+2+3}= ____________________ volts

Calculations

R_1= ____________________ ohms
R_2= ____________________ ohms
R_3= ____________________ ohms

R_{1+2} = ____________________ ohms
R_{2+3} = ____________________ ohms
R_{1+2+3}= ____________________ ohms

B. Series Circuit with unequal loads

Remove the cone heaters and use three unequal light bulbs.

1. Record information about the bulbs here:

	L_1	L_2	L_3
Watts			
Volts			

2. Measure and record the following readings:

I = ____________________ amps
E_1= ____________________ volts
E_2= ____________________ volts
E_3= ____________________ volts

E_{1+2} = ____________________ volts
E_{2+3} = ____________________ volts
E_{1+2+3}= ____________________ volts

3. Calculations

R_1= ____________________ ohms
R_2= ____________________ ohms
R_3= ____________________ ohms

R_{1+2} = ____________________ ohms
R_{2+3} = ____________________ ohms
R_{1+2+3}= ____________________ ohms

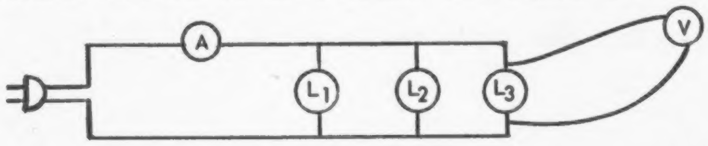
4. Conclusions

What conclusions can you draw with regard to:
- a. The current in various parts of the series circuit?
- b. The total resistance of the circuit?
- c. The voltage applied to the circuit and the voltage across each load?
- d. Other?

C. Parallel circuit with equal loads

Connect an ammeter, voltmeter and three sockets in parallel as diagramed below. Use cone heaters in the sockets.

DO NOT PLUG INTO OUTLET UNTIL IT HAS BEEN CHECKED BY THE INSTRUCTOR.



1. Read and record the volts and amps for each load separately and for the loads in combination. Calculate the resistances.

I_1= ______________ amps E_1= ______________ volts R_1= ______________ ohms
I_2= ______________ amps E_2= ______________ volts R_2= ______________ ohms
I_3= ______________ amps E_3= ______________ volts R_3= ______________ ohms
I_{1+2}= ______________ amps E_{1+2}= ______________ volts R_{1+2}= ______________ ohms
I_{2+3}= ______________ amps E_{2+3}= ______________ volts R_{2+3}= ______________ ohms
I_{1+2+3}= ______________ amps E_{1+2+3}= ______________ volts R_{1+2+3}= ______________ ohms

D. Parallel Circuit with unequal loads

Remove the cone heaters and use three unequal light bulbs.

1. Read and record the volts and amps for each load separately and for all loads in combination. Calculate the resistances.

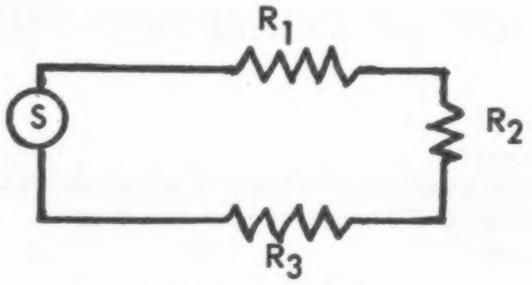
I_1= ______________ amps E_1= ______________ volts R_1= ______________ ohms
I_2= ______________ amps E_2= ______________ volts R_2= ______________ ohms
I_3= ______________ amps E_3= ______________ volts R_3= ______________ ohms
I_{1+2}= ______________ amps E_{1+2}= ______________ volts R_{1+2}= ______________ ohms
I_{2+3}= ______________ amps E_{2+3}= ______________ volts R_{2+3}= ______________ ohms
I_{1+2+3}= ______________ amps E_{1+2+3}= ______________ volts R_{1+2+3}= ______________ ohms

2. Conclusions

   What conclusions can you draw with regard to:
   a. The current in various parts of the parallel circuit
   b. The resistance in a parallel circuit
   c. The voltage applied to the circuit and the voltage across individual loads
   d. Other

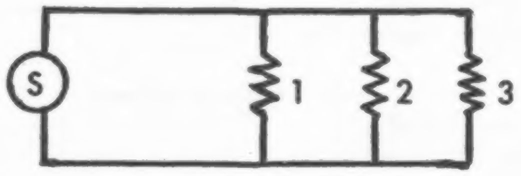
Report (Due at the beginning of next week's lab.)

1. Hand in this lab outline with all calculations completed.
2. What are your conclusions as asked for under B–4 and D–2?
3. Write a brief biographical sketch of the man who discovered Ohm's Law.
4. Calculate the following factors for the circuit shown below:



R_e, I_e, E_1, E_2, E_3
$R_1 =$ 5 ohms
$R_2 =$ 4 ohms
$R_3 =$ 18 ohms
$E_e =$ 115 volts

5. Calculate the following factors for the circuit shown below:



R_e, I_1, I_2, I_3
$R_1 =$ 5 ohms
$R_2 =$ 4 ohms
$R_3 =$ 18 ohms
$E_e =$ 115 volts

AGRICULTURAL EQUIPMENT TECHNOLOGY

LABORATORY REPORT COVER SHEET

______________________ Student's Surname	____________ Initials	Accepted ____________ Rejected ____________ Grade ____________

____
TITLE OF REPORT

____
COURSE TITLE AND NUMBER

Date Report Due: ____________________

Report Criticized for:

☐ Appearance
☐ Arrangement
☐ Calculations
☐ Conclusions
☐ Data
☐ Spelling
☐ Discussion
☐ Grammar
☐ Graphs
☐ Incomplete
☐ Sketches

Instructions:

Revise and return on____________________
Complete and return on____________________
See instructor about this report ☐
See instructions or comments attached ☐

FIELD TRIP OUTLINE

STUDY AND OBSERVATION OF FARMSTEAD MECHANIZATION

1. When was the present layout established?
2. What prompted the type of layout in use?
3. Is this the type of layout one might use on almost any farm or on one that has a certain size? What probably would be the minimum size from an acre standpoint? For the number of milkers?
4. These should be checked for feeding area:
    a. makes of equipment
    b. capacities of equipment
    c. arrangement of equipment
    d. on map—distances or measurements
    e. costs of equipment (where permissible)
    f. manure handling equipment
5. Study of milking area:
    a. Types of stalls—advantages and disadvantages
    b. How many men milk? Length of milking time?
    c. Description of grain feeding—operation, makes, etc.
    d. Milking procedure
    e. Milk-handling equipment—how it functions, makes, types of storage
    f. How is milk weighed? Is it tested for butterfat?
    g. Heating equipment? Type? How does it operate? etc.
6. Other: (The above will not give a complete picture; therefore, add your ideas here.)

U.S. GOVERNMENT PRINTING OFFICE: 1970 O-352-209